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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled Monitoring and Modifying High Levels of Activity submitted by Sandra L. Litman in partial fulfilment of the requirements for the degree of Master of Education.

ABSTRACT

The purpose of this study was to design and validate the use of a prototype activity monitor and feedback system to be used in conjunction with a behaviour management programme to reduce overactive behaviour in a classroom setting. The monitor designed for this purpose measured activity level at each forearm and the mid-torso in order to monitor both gross motor and fine motor activity. An activity was operationally defined as any change in body or upper limb position of greater than or equal to 12^{o} in any direction as measured electronically by mercury switches placed at each target body position. Feedback was provided by means of a 1/2 second, 1000 hertz tone delivered privately through an ear plug to each subject for each movement of either his non-dominant arm or torso. Dominant arm activity was not a target for remediation as activity of the dominant arm is frequently functional. Three 6 year old children whose high levels of activity were found to interfere with their classroom work as well as that of their classmates were chosen to participate in this study. The activity monitor was found to be an easy to use, unobtrusive and reliable device for measuring activity level with these children. To test the efficacy of the treatment programme, an ABA (baseline-

treatment-return to baseline) design was used for two of the subjects, while an AB (baseline-treatment) design was used for the remaining subject. A DRL (differential reinforcement of low rates of behaviour) procedure was instituted. The children all received feedback for movement of their non-dominant arm and torso and reinforcement for successive reduction of activity level of these two body parts. It was found that for two out of the three subjects, activity level of the non-dominant arm declined significantly with administration of the feedback and reinforcement programme, and with all three subjects activity level of the torso declined significantly with this treatment. However, with each subject, contrary to prediction, activity level of the dominant arm, which had received no treatment also declined significantly when the non-dominant arm and torso were administered the treatment programme. Furthermore, with neither of the two subjects for whom a return-to-baseline condition was instituted did activity levels return to their pre-treatment levels. Results are discussed in terms of reinforcement schedules, interdependence of activity levels of various body parts, the activity monitor as a discriminative stimulus (S_D), and trapping. Activity monitor advantages and disadvantages and suggested further uses are also discussed.

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TABLE OF CONTENTS

CHAPTER PAGE

LIST OF TABLES

LIST OF FIGURES

Figure		Page

CHAPTER I

INTRODUCTION

Researchers estimate that between 4 and 15% of the elementary school population exhibit behaviours most commonly labelled hyperactive or hyperkinetic (Heussey, 1967; Stewart, Ferris, Pitts, & Craig, 1966; Wender, 1971). Furthermore, it has been reported that 'hyperactivity' is one of the most common reasons for referral of children to mental health clinics (Patterson, 1964) and to school psychologists (Heussey, 1967). The problem of managing the behaviour of these children is of great concern, not only because of the relatively high incidence of the behaviour, but also because of its disruptive effect in a classroom. The behaviour frequently impedes the classroom learning of both the hyperactive child and his/her classmates. Educators believe that hyperactivity is one of the most difficult behaviour management problems that they encounter (Cromwell, Baumeister, & Hawkins, 1963; Werry & Sprague, 1970).

Children who have been labelled hyperactive are usually described as: (a) inordinately active, (b) distractable, (c) impulsive, and (d) unable to delay gratification. One of these descriptors, high activity level, has been of considerable interest to researchers because it is one of

the most overt and problematic characteristics of the 'syndrome'. The present study focused on the dual problems of measuring and modifying the activity levels of children who have been identified as exhibiting high levels of activity in the classroom. While it is presumed that much of the overactive behaviour may be non-functional or non-goal-related, the validity of this premise remains to be examined in future research. The primary goals of the present study were: (a) to design and test a device that would objectively measure the activity levels of children for whom high levels of activity in the classroom is a problem, and (b) to use the device in conjunction with behaviour management and feedback techniques to modify the classroom activity levels of these children.

CHAPTER II

LITERATURE REVIEW

Introduction

"Hyperactive" is one of many terms commonly utilized to describe a seemingly heterogeneous group of children presenting a wide ranging constellation of behaviours. In the literature, the term hyperactivity has been used synonymously with hyperkinesis, overactivity, minimal brain damage, minimal brain dysfunction, and learning disability as well as numerous other less-frequently utilized terms (Clements, 1966; Juliano & Gentile, 1975; Schrager, Lindy, Harrison, McDermott, & Wilson, 1966; Werry, Weiss, & Douglas, 1964). The various 'symptoms' associated with these disorders generally include combinations of high activity level, short attention span, restlessness, impulsivity, inability to delay gratification, poor (or at least inconsistent) school performance, low frustration tolerance, inability to concentrate and one or more 'specific learning disabilities' (Juliano & Gentile, 1975; Schrager et al., 1966; Werry et al., 1964). In spite of the reported overlap of symptoms and behaviours across these 'syndromes', the inability of researchers to agree as to: (a) which symptoms or behaviours cluster together, (b) the etiology of these syndromes, (c) the efficacy of

various treatment approaches, and (d) long term prognosis, would suggest that these researchers are not collectively focusing on a single pathognomic entity (Juliano & Gentile, 1975; Schrager et al., 1966; Werry et al., 1964).

Sandberg, Rutter, and Taylor (1978) stipulate that a syndrome should only be considered a meaningful entity, if it is clinically distinguishable from other disorders. Furthermore, there should be some degree of consensus concerning which children do and do not manifest signs of the syndrome. Rutter (1965), in his article concerning child psychiatric classifications, adds that for valid syndrome identification, symptoms should correlate or "go together". Not only should there be consensus among relevant experts concerning the symptoms which constitute a particular syndrome, but, in factor analytic studies symptoms should cluster together. Does the term "hyperactivity" qualify according to these criteria as a valid syndrome?

Sandberg, Rutter, & Taylor (1978) bring attention to the very disparate incidence rates of hyperactivity between Great Britain and the United States (1% of the children in the Isle of Wight study, Rutter, Graham, and Yule, 1970; 1½% in the World Health Organization study, Rutter, Schaffer, and Sheppard, 1975; versus U.S. figures ranging from 4 to 10 %; Huessey, 1967; Stewart, Pitts, Craig, & Dienuf, 1966). Sandberg et al. (1978) speculate that the disparity is reflective of different diagnostic usage and not a difference in prevalence. The authors also

point out that the list of symptoms most frequently cited as relevant to hyperactivity cover a "substantial proportion" of children seen in child psychiatric practice and suggest that many of the children diagnosed as hyperactive in the U.S. would be regarded as having a conduct disorder in the U.K. In an attempt to verify this proposition, Sandberg et al. (1978) attempted to distinguish between hyperactive children and other children referred to a child psychiatric clinic, in terms of characteristics generally thought to signify hyperactivity. They found that:

1. the results from Connors' Teachers Questionnaire, Connors' Parent Questionnaire (the two most frequently utilized indices of hyperactivity in the literature, Bowers, 1978) and time sampled behavioural observations did not significantly correlate with one another;
2. there were few significant associations between diagnosed hyperactivity and features generally thought to characterize hyperactivity such as impulsivity, early onset, reading backwardness and neurological signs;
3. both conduct disordered and hyperkinetic children (clinically diagnosed) had comparable hyperactivity scores on the two Connors scales.

Sandberg et al. (1978) conclude that "there is no evidence

for the validity of a broader based concept of hyperkinetic [hyperactive] syndrome defined in terms of questionnaire scores" (p. 294), and suggest that "it would seem best to abandon it [the concept]" (p. 293).

Other researchers support the point of view that "hyperactivity" is not a functional concept. Buddenhagen and Sickler (1969) following a 48 hour minute-by-minute observation of a 13 year old institutionalized mongoloid girl whom the institution staff had long unanimously regarded as extremely hyperactive, concluded that "hyperactivity describes those aspects of a person's behaviour which annoy the observer" (p. 580) rather than any standard set of symptoms or behaviours.

Barkley and Ullman (1975) compared nine observational measures of activity level, three laboratory measures of distractibility and results from a parental rating scale of activity on 52 individuals. The sample consisted of 16 boys who had been referred to a psychological services centre for evaluation of possible hyperactivity, 16 boys who had been referred for problems other than hyperactivity and 20 boys from the local community. Barkley and Ullman found that the measures of activity were only moderately related to one another and that the measures of distractibility were only moderately related to one another. Furthermore, activity and distractibility were not found to be at all related to each other and parental ratings of activity levels were unrelated to observational measures of activity level.

These results indicate that not only are both activity level and distractibility poorly defined concepts, but that a diagnosis of hyperactivity based on either activity level, distractibility or parental rating scores is of questionable validity.

A number of factor analytic studies similarly point out the vagueness of the concept of hyperactivity and suggest that, according to Rutter's (1965) criteria, hyperactivity does not qualify as a valid syndrome. Dreger, Reid, Lewis, Overlade, Rich, Miller, and Fleming (1964), Patterson (1964) and Spivack and Levine (1964) have all failed to find a hyperactivity factor in their factor analytic studies, while Connors (1970), Miller (1976) and Werry, Sprague, and Cohen (1975) have found a hyperactivity factor that overlaps to a great extent with conduct disorder.

Shaffer, McNamara, and Pincus (1974) found that mothers' reports of hyperactivity correlated with a conduct disorder diagnosis (as measured by the Conduct Disorder dimension of the Peterson-Quay Problem Checklist; Quay & Peterson, 1967) but not with direct objective measures of activity level or attention. Furthermore, Shaffer et al. found a relationship between overactivity and impulsivity and the conduct disorder syndrome. Shaffer, McNamara, and Pincus (1974) conclude that "overactivity, inattention and impulsivity are non-specific correlates of a conduct disorder" (p. 13).

Researchers have also found that experts have difficulty agreeing with one another regarding the diagnosis of hyperactivity. Kenny, Clemmens, Hudson, Lentz, Cicci, and Nair (1971) in a study of 100 children referred by school and medical sources to a diagnostic and evaluation clinic primarily because of diagnosed hyperactivity, found that 58% of the children were not considered hyperactive by the majority of the clinic staff, 22% were rated as hyperactive by the majority, 7% by a minority and only 13% were regarded as hyperactive by all judges.

In light of this evidence it would seem safe to conclude that as it is presently defined and evaluated, hyperactivity is at best an elusive construct. Furthermore, according to the criteria described above by Sandberg, Rutter, and Taylor (1978) and Rutter (1965) hyperactivity is not a syndrome.

Though there is no consensus as to what constitutes hyperactivity, there seems to be general agreement in the literature that some children exhibit behaviours which adults construe to be problematic for the adults, others in the environment and/or the children themselves (Buddenhagen & Sickler, 1969; Huessey, 1967; Patterson, 1964). When the frequency, intensity and/or nature of these behaviours are such that the adults in the child's environment are no longer willing or able to tolerate the behaviours, these adults deem intervention necessary.

In the foregoing studies, it is apparent that

"hyperactivity" is difficult to define and assess. Also, "overactivity" appears to be one of the most salient characteristics of children whose behaviour is considered problematic in the classroom (Huessey, 1967; Juliano & Gentile, 1975; O'Malley & Eisenberg, 1973; Wender, 1971). For these reasons, and because "activity level" can be operationally defined, the following study focusses on the analysis of high activity levels in children regardless of their diagnostic category.

Thus, in the following review of the literature, studies are reviewed that addressed themselves to hyperactivity, hyperkinesis or overactivity. The only consideration for inclusion of a study is that the subject population was considered by the significant others in the child's life (parents, teachers, and/or doctors) to have a "high level of activity". Studies focussing on minimal brain damage, minimal brain dysfunction, or learning disabilities are referred to only if they address themselves specifically to the activity levels of the target children.

Activity Level

Werry and Quay (1969) have suggested that methods of behavioural observation in the classroom should be reliable, valid, of utility in a variety of settings, relatively inexpensive, and utilizable by people without professional training. This writer would impose one additional criterion; that the method be relatively

unobtrusive and nonreactive so that the very presence of the instrument will not be responsible for altering the behaviour that it is intended to study. The following paragraphs describe the four methods most frequently used to measure activity level: (a) observational, (b) free space traversal, (c) fidgetometric, and (d) kinetometric.

The earliest attempts to measure activity level probably involved direct visual observation of the subject. Rheingold (cited in Cromwell, Baumeister, & Hawkins, 1963) and Hurder (cited in Cromwell et al., 1963) both obtained reliable measures of activity merely by having an observer count the behaviours over time. Foshee (1958) found high interjudge reliability when he had observers activate a cumulative stopwatch when subjects moved and deactivite it when they stopped moving. Several problems arise with continuous observation and recording of behaviour. That this approach requires the undivided attention of one observer per child renders it costly in terms of both time and labour expended. As well, the repetitive, monotonous nature of the task may lead to observer error. Finally, unless utilized in a specially designed classroom with a one-way observation window, the observer's presence could affect the subject's behaviour.

Videotape equipment capable of recording samples of a subject's movements which the observer later counts during short interval monitoring sessions, has been successfully utilized to obtain a more reliable (and less

fatiguing) assessment of activity levels (Sainsbury, 1954 and Benoit as cited in Cromwell, Baumeister, & Hawkins, 1963). The expense of such equipment, though, is frequently prohibitive and the time must still be taken to study and record the activities. Furthermore, with both the direct and video observations, other children, objects in the classroom, or even the subject's own body (when fine motor activity is relevant) might obscure the camera's view of the target behaviour.

The number of times a child moves from one area of a room to another has been the criterion for evaluating activity level utilized by many researchers, and has been monitored both by direct observation or mechanical means. Foshee, Palk, and Cromwell (cited in Cromwell et al., 1963) divided the floor of an observation room into sections and had an observer count the number of times the subject moved from one section to another. This method suffers from the limitations of previously discussed in situ observer methods. It is expensive (a special environment and observer are needed), time consuming, and the observational method itself could affect the behaviour it is attempting to measure.

Ellis and Pryer (1959) devised a room in which beams of light were crisscrossed and focused on photo-electric cell mechanisms on opposite sides of the room. Movement, defined as the breaking of the light beam, was registered on a counter. This method requires the child to be alone

or with an observer in a specially engineered environment. Results extrapolated from this setting and applied to the classroom or other natural environments would have limited validity and utility.

"Fidgetometric devices" measure the number of times a subject jars a platform or cage that s/he is placed on or in. The stabilometric chair (described by Sprague & Toppe, 1966) rests on springs which trip a switch and cumulative counter when moved. The stabilometric cushion (Cromwell, Baumeister, & Hawkins, 1963) contains a microswitch in the middle of each side of a cushion. Movements of very small magnitude of the buttocks close the circuit on the switches and electronically record the movements. Both of these devices as well as the many variations of them (Cromwell et al., 1963) are very limited in their utility. Not only do they have lead wires and cables attached, but they, especially the variations of the stabilometric chair, are very obtrusive and could disturb others if utilized in a regular classroom environment. Furthermore, these fidgetometric devices would be likely to attract undue attention to the child and could stigmatize him/her. Perhaps, though, their most limiting feature is that they record only in-seat "fidgeting" and once the subject has left his/her seat (not an unusual occurrence for children with high activity levels) activity can no longer be monitored.

"Kinetometric devices" seem to have the greatest potential for measuring activity levels in a child's

natural environment as they generally allow free ranging activity by the child and do not require an in situ observer. They are self-contained devices which incorporate an activity counter. Foshee, Palk, and Cromwell (cited by Cromwell et al., 1963) used pedometers to give an index of activity level with mentally retarded subjects. Shulman and Reisman (1959) devised an "accelerometer" or "actometer" which seems to be the device most frequently used since to measure activity levels in children. The device is an automatic winding wrist watch; one is usually placed on the dominant wrist with another on the ankle. The watch has been adapted so that the watch hands progress around the face of the watch with each movement of the limb, thereby recording acceleration and deceleration as long as the movement is in the same plane as the face of the watch. The device has been reported to have good interwatch reliability (Shulman & Reisman, 1959), but Johnson (1971) reports variations in sensitivity depending on the watches' positioning and unequal sensitivity to some movements because of the device's unidirectionality. A number of devices, mounted on different planes could be placed on each child, but because each such placement requires the use of another watch, the cost would be prohibitive for anything but limited experimental purposes. Furthermore, because of the location and method of its placement it would be noticed by the child and his/her classmates and thus the device itself could be responsible for a change in activity level. In spite of these

limitations, Pope (1970) found this device functional in studying "brain-injured" and "normal" children when the children were required to perform a difficult task, and Bell (1968) found a variation of the actometer to be useful as an objective measure of activity level.

Since the research which forms the basis of this thesis was completed, a number of articles have been written which describe and make use of a device very similar to the one devised for this research (Schulman, Stevens, & Kupst, 1977; Schulman, Stevens, Suran, Kupst, & Naughton, 1978; Schulman, Suran, Stevens, & Kupst, 1979). That device and the studies that have made use of it to date will be described in the discussion chapter.

According to the literature, high levels of activity that impede learning are relatively prevalent in classrooms. However, estimated prevalence statistics for high activity level (including hyperactivity and hyperkinesis) vary greatly depending on the assessment criteria utilized and the populations studied. Stewart, Ferris, Pitts, and Craig (1966) found that 4% of 5 to 11 year old school children in St. Louis were reported by their teachers to be overactive and to have short attention spans. Wender (1971) reported that teachers rate "restlessness" as a problem with 15% of elementary school children. Huessey (1967), using a school questionnaire, found that 10% of the second grade students surveyed were "hyperkinetic".

When looking at children who have been referred to clinics or reported to have behaviour problems, this

incidence rate, as one would expect, dramatically increases. Huessey (1967) in his survey found that 80% of children considered by their teachers to have serious problems were labelled hyperkinetic. Patterson, James, Whittier, and Wright (1965) reported that hyperactivity is the major reason for referral to child guidance clinics. Horenstein (1957) claims that the most serious management problem faced in institutions for retarded children is hyperactivity and according to Keogh, Tchir, and Windeguth-Behn (1974) hyperactivity is the term most frequently used by teachers to describe "educationally high risk" children.

While various devices have been developed which attempt to measure activity level, no attempt has been made to utilize them to estimate the prevalence of overactive children. There is no doubt, however, that high activity level is a serious and widespread problem to those dealing with children.

Do children with high activity levels exhibit higher levels of activity than normal children in all situations and at all times? Research addressing itself to this question, while focussing on the activity levels of brain injured, neurologically handicapped and hyperactive children, suggests that activity levels vary in response to the demands of the situation. Kaspar, Millichap, Backus, Child, and Schulman (1971), comparing neurologically handicapped children with normal 5 to 8 year olds of average intelligence, found no difference in actometer readings in unstructured situations, but a significant difference in structured situations. Pope (1970), in a comparative

study of "brain injured" and "normal" children, divided a room into quadrants and observed the children in undirected play and while performing both simple and difficult tasks. She recorded accelerometer readouts of their dominant wrist and ankle, movements across quadrants and types of movement within quadrants (locomotion, standing, and sitting). In undirected play she found that there were no significant differences in total motor activity between the brain injured and normal groups although the brain injured group had both a greater number and shorter duration of contacts with toys and traversed more quadrants. With a simple task there was also no difference in total motor activity. The brain injured group did, however, manifest increased motor activity when required to attempt a difficult task. Furthermore, Pope found that the "normal" children could inhibit voluntary activity (remain seated) for longer periods of time than the overactive, brain injured children.

Zrull, Westman, Arthur, and Rice (1966) contend that research indicates that hyperactivity is an inability to inhibit motor activity in situations where motor inactivity is a desired goal. There seems to be ample evidence to confirm that overactive children do not exhibit abnormally high levels of activity in all situations, but they are particularly active in situations requiring concerted attention and inhibition of motoric activity.

<u>Treatment Approaches to High Activity Level</u>

The four primary treatment approaches used by researchers and clinicians attempting to reduce high activity levels are: (a) medical, including pharmacological administrations and diet changes, (b) environmental manipulations such as specially engineered classrooms, (c) feedback, and (d) behaviour management utilizing the principles of learning theory.

<u>Medical Treatments</u>. Most medical treatment approaches to high activity level are predicated on the assumption that high activity level is a result of a chemical imbalance in the patient's brain or nervous system which results in this specific type of neurological dysfunction (Valett, 1974). A change in diet or ingestion of drugs purportedly corrects this imbalance.

Both stimulants such as Diazepam, D--amphetamine and methylphenidate (Ritalin), and tranquilizers such as perphenazine, chlorpromazine, mesoridazine, and thioridazine have been utilized to attempt to help children who have problems involving high activity levels (Juliano & Gentile, 1975). The amphetamines or stimulant drugs are currently in most widespread use, although both stimulants and depressants have research findings which both support and deny their effectiveness. The results of these studies often seem to be more a function of the research methodologies used than actual drug effects. Sulzbacker (1973) in a review of 756 studies of the effects of

psychotropic drugs on children found that 72.5% of the studies lacked even minimal controls and direct behavioural observations were rarely utilized.

There is little evidence that in the long term these drugs are beneficial in any way. In one of the few follow-up studies in this area, Weiss, Kruger, Danielson, and Elman (1975) studied three matched groups of "hyperactive" children; one group on methylphenidate, one group being treated with chlorpromazine, and the third group on no medication. After 5 years, no significant differences were found in the emotional adjustment, delinquency rates, WISC scores, academic performance (number of grades failed) or hyperactivity of the three differently treated groups. O'Leary and Pelham (1977) agree that drug treatment of children labelled hyperactive neither seems to correlate with long-term academic improvement nor with amelioration of associated social problems.

Not only is the utility of these drugs in reducing activity levels of this target population questionable, but side effects are widespread. O'Leary and Pelham (1978) report that these drugs lead to a loss of appetite, reduced growth rates, an increase in heart rate and blood pressure, insomnia and not least of all, a dependence on drugs for behaviour control. Juliano and Gentile (1975) conclude that most studies indicate that the adverse side effects of these drugs are greater than

or equal to any beneficial effects they might have. In spite of this, it has been estimated that approximately 200,000 American children (about 2%) now receive amphetamines to control hyperactive behaviour (Ayllon, Layman, & Kandel, 1975). There is no reason to believe that the proportion would be lower in Canada.

In spite of the above findings, the widespread use of drugs to control activity level may be due to their relative lack of expense and ease of administration. As well, drug administration implies that overactivity is a biogenic problem and helps convince the adults responsible for the child (as well as the child himself) that they are doing all they can to help the child and that the matter is essentially out of their hands.

The allegation that elements in a hyperactive child's diet are responsible for his high activity level is based on the premise of chemical imbalance in the body (Ross & Ross, 1976). Feingold (1975, 1976), the major proponent of the theory attributing hyperkinesis to the existence of "salicylate-like" compounds in foods and especially artifical flavours and colours, has proposed a diet devoid of these compounds for his patients who have been diagnosed as hyperkinetic. Feingold and others (Cook & Woodhill, 1976; Feingold, 1976, 1975; Stine, 1976) have claimed widespread success in their use of the "K-P" diet. Unfortunately, these studies are, for the most part either anecdotal in nature or lack adequate experimental controls

and objective measures of both dependent and independent variables. One well-controlled study in this area did report positive results (Rose, 1978). However, by only studying subjects who had been on the K-P diet for a minimum of eleven months; subjects for whom the diet was likely effective, Rose did not consider a cross-section of hyperactive children on the diet and hence jeopardized the validity of her results. Lipton and Wender (1977) in a report on the results of three well-controlled, double-blind experiments examining the relationship between hyperkinesis and food additives, conclude that "the evidence available so far generally refutes Dr. Feingold's claim that artificial food colorings in the diet substantially aggravate the behaviour of children with learning disabilities and hyperkinesis" (p. 13). While this diet might prove effective for a small proportion of hyperactive children (Lipton & Wender, 1977; Rose, 1978), there is certainly no evidence to suggest that it is the panacea that its proponents claim it to be (Ross & Ross, 1976).

Environmental manipulation. One approach to ameliorating hyperactivity by altering the environment (Strauss & Lehtinen, 1947), is based on the premise that the overactive child is suffering from a stimulus overload and that reducing environmental stimuli, often by using cubicles, using simplified academic materials and increasing classroom structure, will increase attending behaviour (Strauss & Lehtinen, 1947; Strauss & Kephart,

1955). There is evidence, however, that hyperactive children do not respond to distracting stimuli significantly more than non-hyperactive children (Carter & Diaz, 1971; Schulman, Kaspar, & Throne, 1965; Sykes, Douglas, Weiss, & Minde, 1971; Worland, North-Jones, & Stern, 1973). Moreover there is evidence that children do not seem to improve in their academic performance from the reduction of distracting stimuli (Shores & Haubrich, 1969) and that, in fact, they may become more attentive and less active when exposed to multiple and various sensory stimuli (Gardner, Cromwell, & Froshee, 1969).

It has also been suggested that children who are not provided with sufficient outlets for normal physical activity (apartment-bound or television addicted) may manifest high activity levels (McNamara, 1972). However, there has been little empirical evidence as to the veracity of this hypothesis or efficacy of providing these outlets (Ross & Ross, 1976).

Feedback. Feedback has been defined as the mechanism by which a machine, device, or organism receives information about the nature and/or effects of its output or behaviour (Solomon & Rosenberg, 1964). Feedback is conceived of as "part of a homeostatic process; the feedback is utilized to determine whether a course of action is the correct one, or whether some alteration is necessary to make it correct" (Solomon & Rosenberg, 1964, p. 197).

The benefits that accrue from providing a learner with knowledge of results or feedback concerning his performance has been attributed, depending on the theoretical orientation of the writer, to the reinforcement, motivational or cognitive effects of the feedback. Nevertheless, that feedback facilitates learning, as well as enables performance of previously learned behaviour, is a widely accepted proposition (Bilodeau & Bilodeau, 1969; Fitts, 1964; Hull, 1943; Skinner, 1938).

Mowrer (1960) and Bilodeau and Bilodeau (1969) distinguish between two types of feedback that can affect the motor performance of an individual. The first type of feedback is from the individual's own receptors (proprioceptive or originating from the sense organs) and occurs during the execution of a task or act. The second type of feedback has its origin in the environment and occurs once the act or task has been completed. The effectiveness of the first type can be demonstrated by observing that people who suffer from _tabes dorsalis_ (involving a loss of sensory feedback from one's legs) are unable to walk (Logan, 1970) or by observing that those with profound hearing loss have difficulty speaking clearly. This first type of feedback involves the individual in an almost continual self-correcting process which enables him to execute various motor tasks already in his repertoire (Mowrer, 1960).

The second type of feedback becomes more important when the feedback cues from the individual's own receptors provide insufficient information to permit adequate self-correcting of the response. This type of feedback would occur in the process of learning a new skill or when the individual's internal feedback mechanisms are either somehow incapacitated or inherently not sensitive enough to the type of information needed. It is this second type of feedback, that provided by the environment, that is of concern in this paper.

Researchers have been unanimous in concluding that regardless of the types of learning or type of subject involved, a positive linear relationship exists between rate of skill acquisition and frequency of information feedback (Battig, Voss, & Brogden, 1955; Bourne, Guy, & Wadsworth, 1967; Bourne & Pendleton, 1958; Levine, 1966; Poulton, 1957).

Rafi (1962) successfully used immediate feedback to help a woman control a severe foot-tapping tic. The feedback consisted of a buzzer which was triggered by spasmodic foot movement. Pineda, Barlow, and Turner (1971) successfully utilized a feedback procedure to reduce a patient's inordinately high rate of speech from 200 words per minute to 130 words per minute. They conducted reading trials where above-criterion speech rate resulted in a white light being flashed, while a speech rate at or below criterion resulted in a blue light being flashed.

Another clinical application of feedback procedures in controlling problematic behaviour was demonstrated by Leitenberg, Agras, Thompson, and Wright (1968) with a claustrophobic patient. The patient was either allowed to time the period during which she felt comfortable in an enclosed space (feedback sessions) or was told the stop watch was unavailable (no feedback sessions). Leitenberg et al. found that the feedback sessions resulted in more improvement (more time spent in the closed room) than the sessions which lacked feedback.

Bernhardt, Hersen, and Barlow (1972) compared the effects of instructions versus feedback in controlling the spasmodic head movement of a man suffering from severe <u>spasmodic torticollis</u>. These researchers found that during trials where a light was flashed whenever the patient exhibited the characteristic head movement, the patient was able to reduce the frequency of these movements significantly. On the other hand, instructions to reduce these movements had no significant effect on their frequency. In the only available study concerning the utility of feedback in controlling activity level, Horgan (1977) found that with educable mentally retarded children, both auditory (buzzer) and visual (light) feedback resulted in improved stabilometric performance, while no feedback resulted in no significant change in activity level.

Leitenberg et al. (1968) in a study similar to the one they conducted with the claustrophobic patient (above) allowed a patient with a severe knife phobia to monitor the time that she could comfortably look at an ordinary kitchen knife. As in the previous experiment, this timing procedure seemed to enable the subject to increase the time comfortably spent exposed to the knife, while with the removal of the timer, progress was retarded. With this study, Leitenberg et al. found that neither adding nor removing contingent praise affected the progress that the subject was making.

Salzberg, Wheeler, Devon, and Hopkins (1971) attempted to evaluate the relative effects of feedback and reinforcement upon the accuracy of letter formation with kindergarten children. Salzberg and his colleagues found that feedback alone was not effective. Only when feedback was provided in conjunction with access to play did accuracy increase.

There is no doubt that reinforcement can be an effective tool in behaviour change programmes (Kazdin, 1977; Sulzer-Azaroff, & Mayer, 1977). Not only does reinforcement provide incentive for specific behaviour change, but it performs a valuable feedback function by identifying the behaviour that is to be changed and by notifying the subject that he has either been successful or unsuccessful in appropriately altering the target behaviour. However, when reinforcement programmes are

established in a natural environment, the reinforcement, of necessity, is usually administered some time after the appropriate behaviour has been emitted. As a result, the subject might have difficulty identifying the precise features of his behaviour that he is being required to change or identifying exactly when he has been successful in changing these target features. The numerous intervening stimuli provided by the environment and the intervening behaviours emitted by the subject between the time that the target behaviour was emitted and the reinforcement administered might make the association between the target behaviour and the reinforcement difficulty to identify.

Agras, Barlow, Chapin, Abel, and Leitenberg (1974) attempted to compare the utility of reinforcement alone with a programme involving reinforcement and feedback with a subject suffering from anorexia nervosa (extensive self-induced weight loss). They found that making privileges contingent upon weight gain did not result in weight gain, while providing information concerning number of calories consumed, number of mouthfuls eaten and weight gained, in addition to the contingent reinforcement, did result in increased caloric intake as well as weight gain. Agras et al. concluded that "knowledge of results . . . is required for reinforcement to be maximally effective" (p. 285).

Behaviour management. Behavioural approaches to the modification of high activity levels or any other problematic behaviours presumes that behaviour is an observable phenomenon which can be studied and controlled without regard to its etiology or hypothetical perceptive, affective, or cognitive processes or states. Behaviour management involves the "application of the results of learning theory and experimental psychology to the problem of altering maladaptive behaviour" (Ullman & Krasner, 1965). The focus is on operant conditioning whereby target behaviours are controlled by their consequences. The frequency of occurrence of behaviours may be increased by making reinforcers contingent upon their occurrence. On the other hand, the frequency of occurrence of behaviours may be decreased when followed by an aversive event (a punisher), when a reinforcer that is presently maintaining the target behaviour is removed, or when an incompatible behaviour is reinforced. When the incompatible behaviour is reinforced, its occurrence increases and the frequency of occurrence of the target behaviour thereby decreases. Application of these behaviour management principles and techniques and derivatives of them as outlined and exemplified by Bandura (1969), Kazdin (1977), and Krasner (1971) has been one of the approaches taken to the treatment of children with high activity levels.

By far the most frequently used behaviour management approach to reducing high activity levels and related

behaviour problems has been that of reinforcing incompatible behaviours. Researchers have attempted to increase: (a) attending behaviour, (b) in-seat behaviour, and (c) academic performance, both because these activities seem to be incompatible with high activity levels and because these are desirable behaviours within the classroom setting and difficulties in these areas are some of the most frequently identified correlates of overactive behaviour.

In a study designed to ameliorate the attention problems of eight institutionalized, retarded, hyperactive children, Alabiso (1975) identified and attempted to increase the frequency of occurrence of three components of attention: span, focus, and selective attention. He operationally defined span as time spent in seat, focus as the frequency of correct responses to a hand-eye coordination task and selective attention as the number of correct responses to a two-stage stimulus discrimination task. He found that by using tokens and social reinforcement he was able to improve all three components of attending behaviour of these subjects and furthermore, that these behaviour changes generalized to the classroom setting.

Allen, Henke, Harris, Baer, and Reynolds (1967), in their investigation of a $4\frac{1}{2}$ year old boy with a severely limited attention span, concluded that teachers making use of systematic and immediate social reinforcers could

shape and maintain attending behaviours. In another successful attempt to increase attention span, Quay, Sprague, Warry, and McQueen (1967) had an observer flash a light mounted on a child's desk for every ten second interval during which the child looked at the teacher during a teaching session. The child subsequently received candy and praise for each flash that he had earned.

While the above studies seem to demonstrate the efficacy of increasing attending behaviours with the use of behaviour management techniques, since they did not measure activity levels, one cannot be certain that the assumption that an increase of attending behaviours necessarily involves a decrease in activity level is valid. Furthermore, these programmes would be difficult and/or expensive to implement in a classroom setting. Alabiso's (1975) approach requires that the child be removed from the classroom and trained: a procedure that is costly both in terms of time and personnel. Both Allen et al.'s (1967) and Quay et al.'s (1967) procedures require an observer to record the behaviours and signal the child or teacher when the child meets the criterion for reinforcement. These, too, are expensive treatment alternatives and could also be disruptive for others in the class.

There is a substantial body of literature that indicates that it is feasible to shape and increase in-seat

behaviour of overactive children with the use of behaviour management techniques. Pihl (1967) attempted to use behaviour management techniques with two overactive boys for whom drug therapy had previously exacerbated their overactivity. He was able to condition these subjects to remain seated for 45-minute periods by dispensing points (exchangeable for candy), for every 25 seconds that they remained seated.

In an attempt to increase sitting with an overactive, mentally retarded boy in a remedial preschool, Twardosz and Sojwaj (1972), using prompting and tokens (exchangeable for trinkets) were able to increase his rate of in-seat behaviour from almost nonexistent to over 40% of the observation period. Patterson, James, Whittier, and Wright (1965) were able to increase sitting of an over-active child to 20-minute intervals first in a laboratory and then in the classroom by using a buzzer followed up by candy for every ten second interval that the child remained seated. In a similar study, Patterson (1965), using a light as a signal and following it up with candy for the overactive child in the lab as well as candy for the child's entire class, found that social reinforcement from peers is also a powerful tool for increasing in-seat behaviours in children. Patterson did note, however, that there was no concommitant increase in academic performance.

The research concerned with the use of behaviour management techniques to reduce out-of-seat behaviour,

seems to indicate that this is an effective treatment mode. However, while in-seat behaviour is certainly incompatible with most gross motor activity, no measures were taken to ascertain whether or not reduction of out-of-seat behaviour corresponds with reduction of in-seat movement of the extremities and/or the type of movement of the torso involved in in-seat "fidgeting".

Edelson and Sprague (1974) attempted to control the activity level, as measured by stabilometric cushions, of retarded, overactive children, by rewarding either increases or decreases in activity levels. They concluded that their procedure is very effective in controlling activity levels of this population. This method of measuring activity, however, as previously discussed, only renders an index of in-seat fidgeting. Once the child leaves the chair there is no record of his/her movement. The limitations of the stabilimetric cushions limit the generalizability of these results and the utility of this method of modifying activity levels in a natural setting.

Ayllon, Layman, and Kandel (1975) examined the relative effects of behaviour management programmes versus psychotropic drugs (Ritalin) on hyperactivity and academic performance. They found that dispensing tokens for improvement in academic performance was as effective as the drug treatment for decreasing behaviours labelled as hyperactive. However, the students' math and reading scores increased from 12% under the drug treatment

programme to 85% correct under the behaviour management programme. It is also interesting to note that when these children were initially taken off their drugs, their level of activity increased, as did their academic performance. Pelham (1976) similarly noted in his research that when stimulant drugs were withdrawn and a behaviour management programme instituted, the children's school performance improved substantially.

The literature seems to indicate that behaviour management techniques are a very viable means of helping children who have high activity levels and consequent school related problems to control their own behaviour. However, with most of the research cited involving behaviour management of both out-of-seat and attending behaviours, the monitoring of the target behaviours is a time consuming task which, in the majority of cases cited, would require an external observer, an expensive and often obtrusive means of monitoring behaviour.

CHAPTER III

STATEMENT OF THE PROBLEM

It is evident from the preceding literature review that overactivity in children is a widespread phenomenon that affects not only the involved child but his/her peers and that teachers have difficulty dealing with this problem behaviour in the classroom. Furthermore, overactivity influences the involved child's academic achievement as well as his/her social adjustment. The literature also indicates that a reliable, easy to use and unobtrusive means of measuring activity level is needed. This type of device would be of use as a diagnostic instrument, to assess the efficacy of treatment approaches and to provide additional information as to the nature and correlates of overactivity. Finally, research must be carried out to see whether or not activity levels of overactive children, as defined and monitored by such a device, can be reduced by means of behaviour management techniques augmented by immediate information feedback. The study described in the following chapters represents this writer's attempt to develop and validate the use of a prototype activity monitor and feedback system to be used in conjunction with behaviour management techniques to reduce overactive behavour in the classroom.

The two general hypotheses that are to be tested by this study are: (1) A reliable and unobtrusive activity monitor and feedback device that can be easily utilized in a classroom setting can be developed, and (2) activity levels of overactive children can be reduced by means of positive reinforcement and immediate information feedback. More specific hypotheses will be stated later in relation to the specific device and treatment procedures employed.

CHAPTER IV

METHOD

Research Instrument

The activity monitor developed for this research was intended to overcome some of the limitations that were endemic to existing methods of measuring activity levels. It was designed to be small, lightweight, relatively unobtrusive, self-contained, comfortable to wear, easy to use, and a reliable measure of overactive behaviour in the classroom. It was also designed to incorporate a direct auditory feedback device to inform each subject precisely when s/he is being active. It was intended that a teacher be able to easily make use of the device with an overactive child within a classroom setting with a minimum amount of disruption or outside help.

The device designed to meet these and more precise specifications described below was developed by Dr. Patrick Harding of The University of Alberta, Department of Electrical Engineering in consultation with this writer. The device itself consists of five mercury contact switches which feed into a readout panel. Each switch consists of two wires and a pool of mercury enclosed in a glass tube. The wires are connected by contact with the mercury pool and disconnected by loss of contact. This pool of mercury is moved back and forth in the tube by altering the position of the tube (switch).

The switches are placed, two at right angles to one another at each wrist and one in a horizontal position at the upper back

of the child. The switches are connected to the readout panel by wires enclosed within the lining of the sleeves of a shirt worn by the child. Output from each body position is independently recorded and independent readout is displayed.

The readout panel of the monitor fits into a cotton pouch sewn onto the mid-back of the shirt. The shirt, when in use, can be worn over a cotton t-shirt. The pouch is fastened with velcro strips to allow easy access. The positions of the mercury switches are also fastened to the shirt with velcro strips to permit the experimenter to adjust the switches to various positions to correspond with what the experimenter has defined as an activity.

The mercury switches make contact each time their vertical orientation is altered, in the present study by more than 12^0. Mercury switches sensitive to 5^0, 12^0, and 20^0 angle changes are available. The 12^0 angle was chosen after watching the target children in their classrooms and observing that movements that involved more than a 12^0 change in orientation become noticeable and problematic when engaged in at high frequencies. The right angle placement of two such switches helps ensure that movement in more than one direction will be monitored. During pilot testing, it was confirmed that most movements of the torso and arms, including both fine and gross motor activity, were registered by this method of placement of the switches.

Each contact closure by each switch triggers an electronic circuit which deactivates the switch for one

second. The switch is deactivated in this way so as to limit activity overestimates that occur as a result of mercury bounce. Furthermore, deactivating the switches for one second ensures that only one activity is registered for each body movement at a particular position even though both mercury switches at a body position might have had their vertical orientation altered by more than 12^0. The electronic circuit feeds the information into a counter. The output of each counter is then displayed by LED's (light emitting diodes) when a prescribed combination of rocker switches on the readout panel is depressed.

This device was also designed so that a ½ second, 1000 hertz tone would be provided privately to the subject by means of a standard transistor radio-type earphone each time either the non-dominant arm or the torso registered a movement. Activity of the dominant arm did not trigger feedback so that necessary task-related behaviours, such as writing or raising the hand to ask or answer questions would not be affected. For a more technical description as well as circuit diagram of this device, see Appendix I.

This activity monitor does not require an observer to be present in the classroom, is entirely self-contained and so does not impede the child in any way within the classroom. The classroom teacher can easily be taught to record the readout at the end of each session. Directions that teachers were given for recording activity levels from the device can be found in Appendix II.

Any reliability figures obtained for this device would only represent the reliability of the device as it was set up for and under the conditions of that reliability study. The monitor's firing is dependent on a number of variables which can be adjusted to measure the type of movement that is of particular concern in each case. To begin with, mercury switches are available which trigger electrical response at various angle changes. It is possible, by altering mercury switches, to make the device sensitive to either more or less gross activities. Furthermore, the placement of the mercury switches both on their own and in relation to one another when they are set in tandem, dictates the type of movements to which they will respond. For example, placing a switch in the vertical position so that the mercury is either on the top or bottom of its tube when the subject is at rest () will require a greater magnitude of movement to trigger the device than placing it so that it is in an almost horizontal position when the subject is at rest, (). For each subject, pilot testing must be carried out to ensure that the device is measuring the type of movements that are seen as being problematic for that child. The settings may remain standardized for any group of children engaged in similar types of problematic activities. While these variables increase the functional flexibility of the device, they render its standardization very difficult.

Interjudge reliability was chosen as an appropriate reliability measure for this device. This reliability test yielded an index of the extent to which the monitor's activity counts corresponded to independent observers' measures of activity levels for the experimental subjects engaged in a standard set of activities. An independent measure of interjudge reliability was then ascertained for each subject involved in the study.

It was decided to use an ordinal (ranking) statistic rather than an interval statistic (for example, Spearman's reliability coefficient) because of the systematic differences in perception between the human judges and the monitor that invariably resulted in human judges' underestimates. The human judges' counts were consistently below those of the monitor because they miss many movements that the device was able to detect when (1) the target body part was hidden by the rest of the child's body, (2) the target body part was hidden by an object in the room, or (3) when the child stepped out of the camera's range. While these handicaps of the human judges argue that the monitor would be more likely to provide a more accurate count of actual frequencies of activity, they would have also resulted in a very low traditionally-calculated reliability coefficient.

In order to measure interjudge reliability, each child was videotaped wearing the activity monitor (minus the feedback apparatus) while engaging in activities that were representative of classroom activities ranging from free

play to oral reading and working at classroom workbooks. The videotaping took place in a small playroom equipped with a small table and chairs, a variety of toys and a selection of classroom materials provided by each child's teacher. Only the target child and the experimenter were in the room during the videotaping: the camera was remotely operated. At the beginning of each subject's reliability testing sessions, the activity monitor was demonstrated to the child. He was told that the shirt was intended to measure how much children move around and that the experimenter needed the child's help to see if it really worked properly. The child was then told that he would be asked to engage in a series of activities, each for a few minutes, and that at the end of each activity the experimenter would read the numbers from the pouch at the back of his shirt. There was, then, both a videotape recording and an activity monitor readout for each of the activities that each child was asked to engage in.

Three judges (Educational Psychology graduate students trained in observational skills) independently viewed the video performance of each child and counted the number of times the child moved either forearm and his torso (corresponding to the three positions of the mercury switches). The judges therefore watched each film clip three times to allow separate and relatively accurate counting. A movement was defined for the judges as any change in position or attitude of the target body part

of greater than or equal to 12^0 in any direction. At the beginning of the reliability study the experimenter and each of the judges individually reviewed a videotaped session and achieved consensus as to what constituted an occurrence of a target behaviour.

In order to assess the degree of agreement amongst the judges and the monitor,their activity counts were ranked. The segment of film where a judge reported the highest activity counts was ranked #1 for that judge and so on. The rankings of each judge and the monitor were then compared with one another.

Kendall's coefficient of concordance (W) (Ferguson, 1971) was chosen to compare rankings as it was considered to be appropriate as a "measure of the relationship among several rankings of N objects or individuals" (Siegel, 1956, p. 229) and so appropriate for this data. Siegel also claims that Kendall's coefficient of concordance is particularly useful as a measure of interjudge reliability. Because it was expected that some relationship between the judges' and monitor's assessments of activity levels would be found, an attempt was made to disprove the null hypothesis of no relationship between the rankings of the three judges and the monitor or among the judges alone.

If there was perfect agreement among judges' (or judges' and monitor's) rankings, W would equal 1. Maximum disagreement would be reflected by a W of 0. Therefore, the closer W was to 1, the more likely it would be that the judges and monitor were applying similar criteria in judging the activity levels of the children and the greater the interjudge reliability of the monitor would be. It should be noted that W is not a standard reliability coefficient and cannot be interpreted using those standards. To test the significance of the coefficient of concordance for $N \geq 7$ (as is the case in the present study), a χ^2 test was applied.

The above described reliability test was conducted over eight activities for subjects 1 and 2, and over ten activities for subject 3. The data was first analyzed making comparisons among the ratings of the three judges and the monitor, and then among only the three human judges to see if there was more or less agreement among the judges when the monitor's ratings were not included. The coefficients of concordance (W), the χ^2's obtained from this data and their levels of significance can be seen in Tables 1 and 2.

From this data, the null hypothesis of no relationship among the rankings of the judges and the monitor can be rejected with a high degree of confidence. In no case was there a significant ($p \geq .05$) difference among the rankings of the three judges or three judges and the

Table 1

Summary of Interjudge Reliability Data

With Three Judges and Activity Monitor

Subject and Monitor Placement	D.F.	Coefficient of Concordance (W)	χ^2	Probability Level
Subject 1 Right Arm	7	.848	23.750	$p < .01$
Subject 1 Left Arm	7	.792	22.167	$p < .01$
Subject 1 Torso	7	.741	20.750	$p < .01$
Subject 2 Right Arm	7	.884	24.761	$p < .001$
Subject 2 Left Arm	7	.685	19.167	$p < .01$
Subject 2 Torso	7	.875	24.510	$p < .001$
Subject 3 Right Arm	9	.823	29.630	$p < .001$
Subject 3 Left Arm	9	.882	31.767	$p < .001$
Subject 3 Torso		Monitor inoperative		

Table 2

Summary of Interjudge Reliability Data

With Three Judges (Without Activity Monitor)

Subject and Monitor Placement	D.F.	Coefficient of Concordance (W)	χ^2	Probability Level
Subject 1 Right Arm	7	.926	19.444	$p < .01$
Subject 1 Left Arm	7	.857	18.000	$p < .05$
Subject 1 Torso	7	.937	19.667	$p < .01$
Subject 2 Right Arm	7	.944	19.829	$p < .01$
Subject 2 Left Arm	7	.672	14.111	$p < .05$
Subject 2 Torso	7	.891	18.713	$p < .01$
Subject 3 Right Arm	9	.930	25.105	$p < .01$
Subject 3 Left Arm	9	.949	25.615	$p < .01$
Subject 3 Torso		Monitor inoperative		

device. In ten cases χ^2 was significant with $p < .01$ and in four cases, $p < .001$. Furthermore, the χ^2's and therefore the confidence intervals were higher when the monitor was included as a judge than when it was not. It can therefore be concluded that this activity monitor as it was set up for these children and for use with the types of activities that were engaged in by the children for purposes of this reliability check is a reliable instrument for monitoring activity levels.

Treatment Procedure

The behaviour management procedure utilized in this study was differential reinforcement of low levels of response (DRL) (Sulzer-Azaroff & Mayer, 1977). This approach is particularly appropriate when there is a behaviour that one wishes to reduce in frequency but not eliminate. It is a non-aversive procedure for reducing inappropriate behaviour. In rewarding something less than complete cessation of the behaviour the procedure informs the subject that he can engage in that behaviour, but in moderation. To attempt to eliminate all activity in a classroom, is likely impossible and obviously inadvisable as some activity is certainly functional. With DRL, reinforcement is provided "when the number of responses (n) in a specified period of time is less than or equal to a prescribed limit" (Deitz & Repp, 1973).

The DRL procedure has been shown to be effective in reducing talking-out behaviour in TMR children (Dietz &

Repp, 1973), in reducing talking-out of an eleven year old boy and in reducing out-of-seat behaviour of a twelve year old girl (Dietz & Repp, 1974).

In the present study, successively lower rates of activity were reinforced. Because acceptable classroom behaviour includes writing (involving dominant hand movement) as well as hand raising to ask and answer questions, it was decided that movement of the dominant arm would merely be monitored with no attempt being made to modify it. It was believed that because of the functional independence of the two arms, it would be possible to modify the activity level of one arm independent of the other.

In addition to employing reinforcement to reduce activity level, the subject also received direct auditory feedback from an earphone for every movement of his non-dominant arm and torso.

Each child was told at the beginning of the baseline sessions that the experimenter was trying to see how well the device operated in the classroom. To offer incentive to wear the device, the child was also told that after the device had been worn on a daily basis for a period of two weeks it would be possible for him to win prizes. At the beginning of the treatment period each subject was introduced to the earphone and auditory feedback. He was told that now, in addition to wearing the shirt, he would be able to win stars that he could trade-in for prizes if he could move around less than usual. Furthermore, he was informed that

he would hear a beep from the earphone when he moved to remind him to move less. While these instructions and information could have in themselves affected the child's performance, they were necessary to ensure that the children made the connection between the auditory feedback and target activity. This connection is a sine qua non of an effective feedback program.

The teachers were fully informed about the procedure prior to its implementation. They were asked not to alter their manner of responding to the children in any way. They were taught how and when to put on the shirts and earphones as well as how to record the readout. Instructions given to the teachers for operating the monitor can be found in Appendix II. The parents were similarly fully informed regarding the intent and procedure of the experiment. The parental authorization and consent form can be found in Appendix III.

Research Design

This study involves a single-subject design. A single-subject design is considered a valid approach in behavioural research as it compares a subject's behaviour under varying conditions and does not allow intersubject differences to mask an individual's behavioural change (Sulzer-Azaroff & Mayer, 1977). Although results may have limited generalizability to the extent that individual and situational differences affect the outcome of the

research, replication of results across subjects increases the generalizability of these results.

The type of single-subject design chosen for use in this study was the reversal design. The reversal design characteristically involves measuring baseline performance of a target behaviour, introducing an intervention strategy, measuring resulting performance, and then returning to the baseline conditions and again measuring performance. This is called an ABA (baseline, intervention, return-to-baseline) design. If the target behaviour is altered from its baseline condition with the introduction of the intervention and then returns to its baseline level with the removal of the treatment programme, then there is convincing evidence that it is the treatment that is responsible for the change in the target behaviour (Sulzer-Azaroff & Mayer, 1977).

Hersen and Barlow (1976) point out that from a clinical perspective it is inadvisable to improve an undesirable behaviour and then for the purposes of demonstrating experimental control of the behaviour withdraw the therapy, reinstate the undesirable behaviour and then terminate the study. For this reason, Hersen and Barlow suggest using an ABAB design where the treatment variable is once again introduced. Not only does reintroducing B demonstrate once more that it is the treatment variable that is responsible for the behaviour change, but the ABAB design terminates on the treatment phase of the programme which can then be extended for clinical purposes. While the argument for the use of the ABAB design in

preference to the ABA design is convincing, time constraints made its use in the present study impractical. Furthermore, in the way of an ex post facto rationale, the data indicated that the subjects failed to return to their previous base rate activity levels and so the clinical dilemma of terminating the study after reinstating the undesirable behaviour never arose.

In the present study, subject 1's right forearm, left forearm and torso activity levels were measured for 36 sessions in order to obtain baseline activity rates. (A session consisted of a distinct period of classroom time ranging from 10 to 30 minutes during which either a lesson was taught or the child was required to engage in seatwork.) The intervention strategy was then initiated and proceeded for 29 sessions. The dominant arm received no treatment, while a feedback and a reinforcement programme were provided for the non-dominant arm and torso.

A return-to-baseline period was not instituted with the first subject as the experiment only began with the child six weeks before the end of the school year and term ended before the return-to-baseline sessions could be conducted. This design is called an AB (baseline, intervention) quasi-experiment (Campbell & Stanley, 1966). Hersen and Barlow (1976) discuss the advantages and disadvantages of the AB design and conclude that while it is preferable to a straight case study (B design), the AB design is "subject to a host of confounding variables",

"results in rather weak conclusions" and should only be utilized "as a last resort measure when circumstances do not allow for more extensive experimentation" (p. 170).

With subjects 2 and 3, the ABA design was utilized with 24 and 28 baseline sessions respectively and 35 and 37 intervention sessions respectively. A return-to-baseline period of 21 and 17 sessions respectively was also instituted.

Rewards

Appropriate rewards were decided upon a priori in consultation with teachers, parents, and the children themselves.

With subject 1, a list of 10 reinforcers was decided upon, some to be administered at home and some by the teacher at school. Reward values were decided upon by the child's ranking of the rewards that his mother, teacher and he agreed would be both to his liking and feasible to administer. The child earned stars according to the number of activities per minute below criterion he achieved during each session. At the end of each session (or at an appropriate break in that day) he could place his stars on a chart and accumulate them until he had enough to buy one of the rewards that he had chosen. This method worked well with this child as his mother was very interested in the program and eager to actively participate.

On the other hand, the parents of the other two children were not as cooperative. They were willing to

have their children participate in the programme, but hesitated to become involved themselves. Furthermore, because the children were in the same class their teachers thought it advisable to provide the same set of reward options for them. Subjects 2 and 3 were given a list of reward options that their teachers and parents thought would be appropriate for the children and to their liking. The children then ranked the rewards in their order of preference. One type of reward that they both ranked high on the list (small metal die-cast cars) was then selected by the researcher for use as a large reward and one type of reward that they both ranked somewhat lower on the list (candy) were chosen as a small reward. A selection of large and small rewards was purchased and the children were then allowed to make their own choice at the appropriate time from the appropriate type of rewards. As with the first child, these two children earned stars for the number of activities per minute below criterion they registered during each session and at appropriate times they could trade in a previously prescribed number of stars for either a large or small reward. In addition, all three children had their stars posted on their own personal chart on the wall of their classroom.

The criterion level of activity that the subjects had to meet in order to earn their rewards varied from subject to subject and changed as each subject's behaviour changed. The primary factors taken into consideration in

establishing criterion activity levels were:

(a) the _initial_ criterion activity level should be 1 or 2 movements per minute above the subject's previous average activity level so that the subject was clearly capable of earning rewards, but still had to move less than he had during many of the baseline sessions.

(b) When the subject's activity level reduced, the criterion for reward also became more stringent (although still readily attainable) so that the subject was required to continue to reduce his activity level and so that he did not become satiated on rewards that were too easy to attain.

It was assumed that as a subject's activity level reduced it would become increasingly difficult for him to further decrease his activity level. Therefore, as criteria and activity level decreased, the difference between criterion and attained activity level necessary to earn a reward was decreased.

The initial criterion for subject 1's non-dominant arm was 25 movements per minute. He received a star for every five movements per minute he registered below criterion for each session. When his criterion became less than 20 movements per minute, a reduction of only two movements per minute was required to earn a star and when less than 10 movements per minute, a reduction of only one movement per minute was required. The initial criterion for subject 1's torso was 30 movements per minute. The

rules for earning stars for reductions in torso movements were the same as they had been for this subject's non-dominant arm.

The initial criterion for subject 2's non-dominant arm was 30 movements per minute. He received a star for every five movements per minute he registered below criterion for each session. When his criterion became less than 20 movements per minute, a reduction of only two movements per minute was required to earn a star and when less than 10 movements per minute, a reduction of only one movement per minute was required. The initial criterion for subject 2's torso was 95 movements per minute. He received a star for every seven movements per minute he recorded below criterion each session when his criterion was between 45 and 95 movements per minute, for every five movements per minute below criterion when his criterion was between 20 and 45 and for every two movements per minute below criterion when his criterion was less than 20 movements per minute.

The initial criterion for subject 3's non-dominant arm was 25 movements per minute. He received a star for every five movements per minute he registered below criterion for each session. When his criterion became less than 20 movements per minute, a reduction of two movements per minute was required to earn a star and when less than 10 movements per minute a reduction of only one movement per minute was required. For subject 3's torso, an initial criterion of 4 movements per minute was established and he

earned a star for every movement he recorded below this criterion.

For each child at the end of every 2 (or 3) sessions, the average movements per minute below criterion for those sessions was calculated. This figure was then subtracted from the previous criterion (or added if the child's activity level had increased) to yield the criterion for the subsequent series of sessions.

Subjects

Three subjects were chosen as most appropriate for inclusion in this study from a list of seven who were potentially available to this experimenter. The criteria for subject inclusion in the study were:

1. The child had been labelled by his/her teachers and parents as hyperactive, hyperkinetic, or overactive.

2. His/her overactivity was assessed by his/her teacher as being both disruptive to others in his/her environment and impeding his/her classroom teaching.

3. This researcher, upon observing the child in his/her classroom agreed with the teacher that the child's activity level was both disruptive in the classroom setting and seemed to impede the child's classroom learning. These conclusions were drawn on the basis of the proportion of time the child was observed to be in his/her seat, attending to the teacher when appropriate, attending to his/her seat work when appropriate, and making verbal or tactile contact with fellow students.

4. To reduce the likelihood of confounding variables contaminating the treatment effects, no subject could be on any medication intended to control his/her high activity level either during or for at least one month prior to this experiment to ensure that there were no residual medication traces in the child's bloodstream that could affect behaviour.

<u>Subject 1</u>. This child was 6 years old and in grade 1 in a regular classroom at a school within the Edmonton Public School Board jurisdiction. He had been assessed by his teacher, parent, and physician as being of average intelligence (no formal test results were available), and hyperactive. He was not failing in school, but was well below average in his academic achievement. His teacher reported her belief that if only this child could sit still long enough to get some work done, he would do quite well. She added that at those times when he seemed particularly interested in the work or otherwise motivated, he was quite capable of satisfactory work. Preliminary observations of the child in the classroom indicated that he exhibited more non-task related movements (moving his hands and feet without apparent purpose) than the other children in the classroom. As well, he was involved in more gross motor activity than most of the other children in his class.

Subject 1 had been on medication (Ritalin) intended to reduce his activity level for six months at the beginning of grade 1. His teacher had noted few significant

changes in his behaviour and his mother reported that the side effects had far outweighed any benefits that she had observed. At the time of the study, he had been off medication for two months.

Subject 2. This child was 6 years old and in attendance in a grade 1 readiness class at the Glenrose Hospital School, serving the needs of children with physical, emotional, behavioural, educational and/or speech problems. He had been assessed by a psychologist to be of low-average intelligence and had a cleft palate and hare lip which resulted in facial disfiguration and severe speech articulation problems. The psychologist reported that this child was "extremely hyperactive" and "distractible" with a tendency to run, climb, and jump with little regard for the safety of himself or others. Subject 2 often seemed barely in control of his own behaviour and certainly not often within the control of others. He tended to flit from one activity to another, rarely finishing anything he started. When the teacher was able to compel him to sit in his seat, he would disturb those around him by leaning over their work, poking them, and talking to them. He also seemed to engage in much seemingly aimless small motor activity. Although he had been labelled hyperactive, he did not undergo drug treatment for this problem until after this experiment was completed.

Subject 3. This child was also in attendance at the grade 1 readiness class at Glenrose Hospital school. He

had been labelled both emotionally and intellectually mildly retarded although the psychologist reported that the child's lack of cooperation throughout the testing session probably resulted in an underestimation of his intellectual capacities. Subject 3 was receiving treatment for delayed language development. He was reported to be non-compliant, aggressive, overactive, and disruptive in a classroom setting. This experimenter did observe that in class, the child was more active than most of the children in his class and that he frequently disturbed others, although he did exhibit short periods of low activity levels when he was engaged in seat work. This child did not seem to demonstrate as much aimless small motor activity as the other two children. Rather, his overactivity seemed typically to be of the gross motor type including rocking his chair, standing up from his seat, and running around the classroom.

Thus the three children in the study represented a cross-section of overactivity in the classroom. Their overactivity ranged from excessive fine motor activity, including movement of the extremities to gross motor activity, including rocking and out-of-seat behaviours.

Specific Hypotheses

The hypotheses that were to be tested by the above described experimental design are stated as follows:

Hypothesis 1. The activity level of the non-dominant arm of each subject will be significantly lower during the treatment phase of the program than it was during the baseline phase.

Hypothesis 2. The activity level of the torso of each subject will be significantly lower during the treatment phase of the programme than it was during the baseline phase.

Hypothesis 3. The activity level of the dominant arm of each subject will not alter significantly throughout the programme.

Hypothesis 4. When the treatment programme is withdrawn for the non-dominant arm and torso of subjects 2 and 3, the activity levels of these body parts will be significantly higher than they had been during the treatment phase of the programme. In other words, the withdrawal of treatment programme will be successful in returning activity rates to their baseline levels.

CHAPTER V

STATISTICAL PROCEDURES AND RESULTS

Method of Data Analysis

The reversal design (ABA or ABAB) has been considered the vehicle for "most of the success of operant behaviour modification procedures in practical settings" (Gentile, Rodin, & Klein, 1972, p. 1). However, interpretation of how large an inter-treatment change is to be considered significant is often a serious problem (Gentile, Rodin, & Klein, 1972). While dramatic changes can be unambiguously interpreted, problems arise when graphically presented data demonstrate changes of visually questionable significance. Gentile, Rodin, and Klein (1972) suggested that the analysis of variance model is an appropriate statistical tool to test for a significant change of behaviour in the reversal design. However, the flurry of rebuttals that followed this proposal (Hartman, 1974; Kratochwill, Alden, Demuth, Dawson, Nanicucci, Arntson, McMurray, Hempstead, & Levin, 1975; and Thoresen & Elashoff, 1974) unanimously pointed out that this design violates a critical assumption of the analysis of variance model; that of independence of the observations or measures. A presumption of serial independence of successive observations of a single behaviour emitted by a single subject is at best of questionnable validity and should not be made unless statistically warranted.

Glass, Willson, and Gottman (1975) furthermore point out that even if the assumption of independence of measures is valid, an analysis of variance or *t*-test approach, both of which make use of baseline and treatment means, could either find a significant difference when there is none or conclude that there is no significant difference when one actually exists. For example, if a time series plot of data drifts gradually upwards, changing neither in direction nor level with the introduction of the intervention, baseline and treatment means would be different even though the intervention had no effect (see Figure 1A). On the other hand, a series which changes in direction with the introduction of the intervention could have identical baseline and treatment means even though the intervention had a significant effect (see Figure 1B) (Glass, Willson, & Gottman, 1975).

As an alternative, Glass, Willson, and Gottman (1975) propose the use of a time-series analysis to analyze significance of change in single subject designs. The purpose of a time-series analysis is to "account for the dependence in serial observations and correct for it so that intervention effects can be estimated and tested with standard techniques which assume independent observations" (Glass, Willson, & Gottman, 1975, p. 78).

The time series analysis proposed by Glass and his colleagues involves calculating a series of autocorrelation coefficients in order to identify the degree of serial

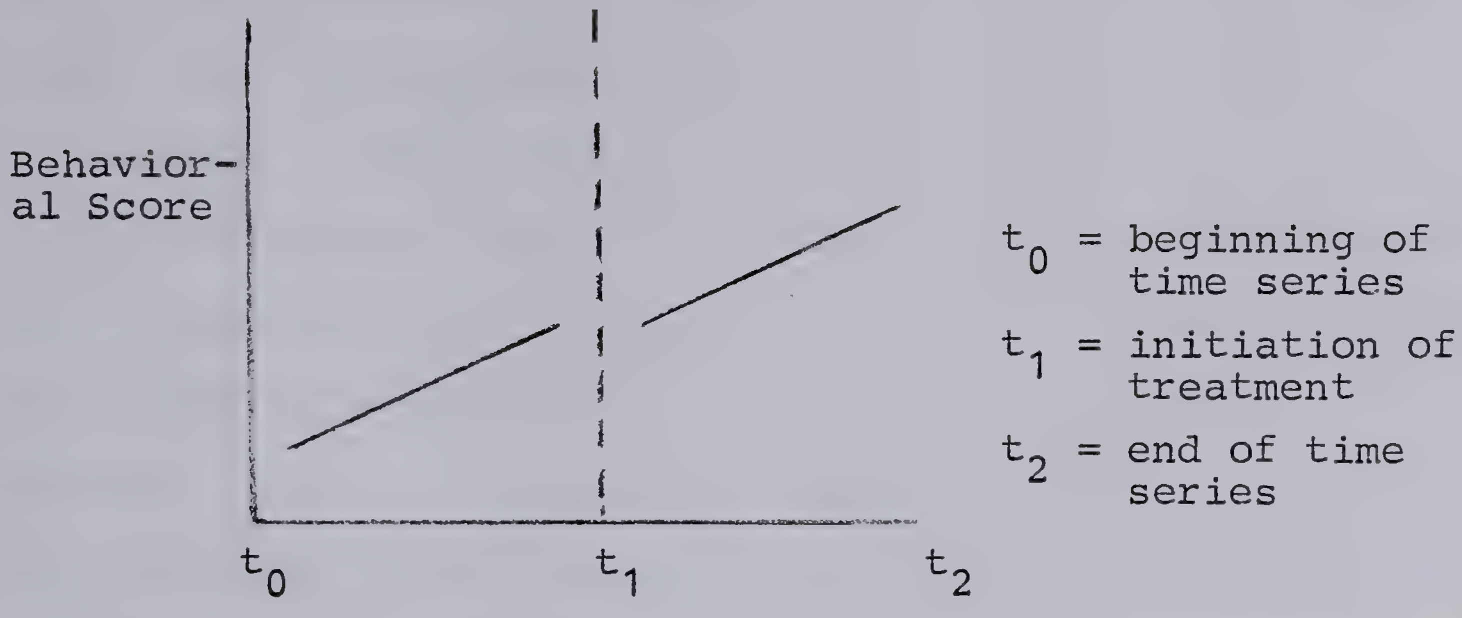


Figure 1A. Time series behavioural recordings indicating no change in trend and no change in level.

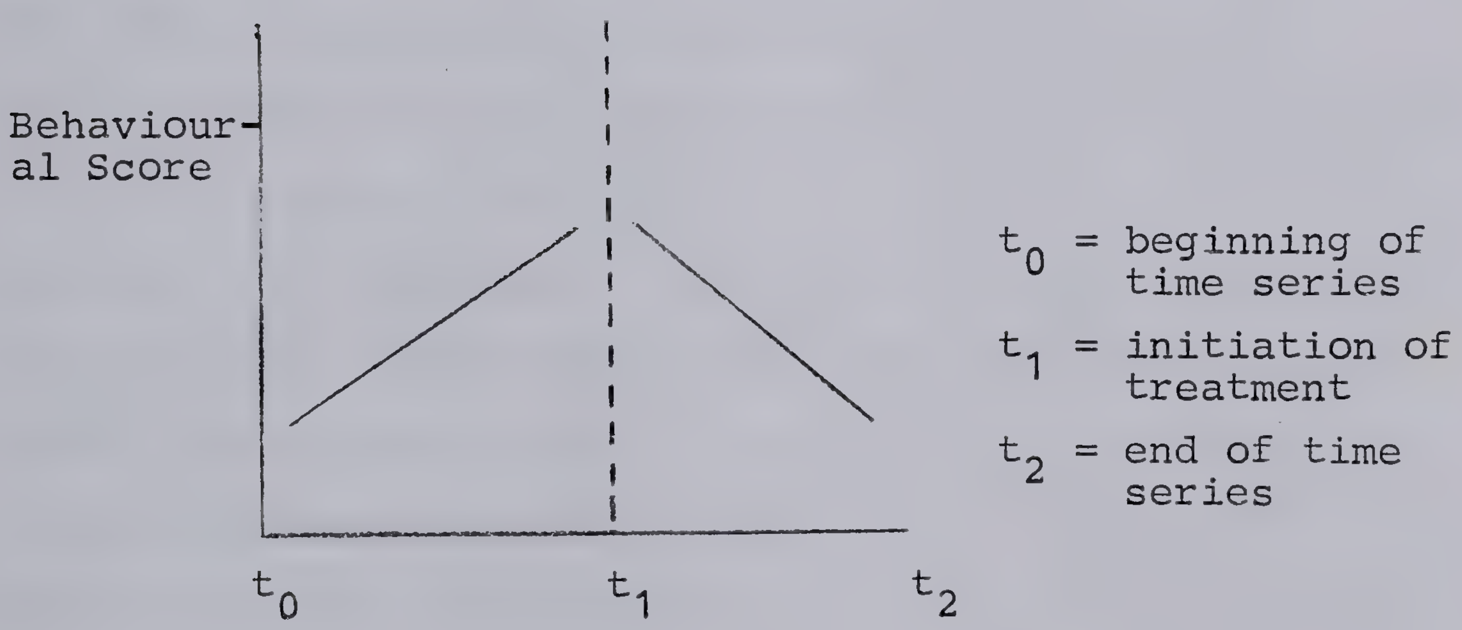


Figure 1B. Time series behavioural recordings indicating change in trend but no change in level.

dependence of successive observations.

With the data of all three subjects under all conditions, an autocorrelation was calculated and it was found that the successive observations were, in fact, independent. This finding indicates that the analysis of variance assumption of independence of measures can be met in this particular study. Therefore, a one-way analysis of variance (Ferguson, 1971) along with a regression analysis (Walker & Lev, 1953) to test for changes in slope that the analysis of variance would overlook, would be appropriate tests of changes in activity level.

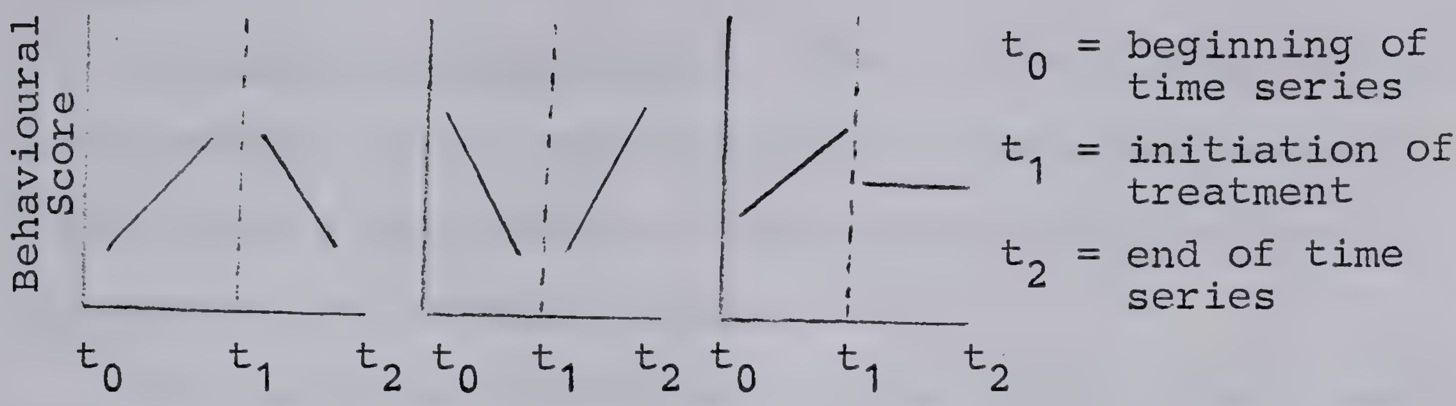
All four hypotheses were tested by completing a one-way analysis of variance for each subject for each of the non-dominant arm, dominant arm, and torso activity levels. Wherever a significant difference was found, a Scheffé multiple comparison test was done to see between which conditions (baseline-treatment-baseline) the significant differences occurred. If hypothesis 1 (The activity level of the non-dominant arm of each subject will be significantly lower during the treatment phase of the programme than it was during the baseline phase) was valid, a significant treatment effect (overall _F_) would be found for the non-dominant arm of each subject and a significant difference would be found between baseline and treatment. If hypothesis 2 (The activity level of the torso of each subject will be significantly lower during the treatment phase of the programme than it was

during the baseline phase) was valid, a significant treatment effect (overall *F*) would be found for the torso of each subject and a significant difference would be found when baseline and treatment phases were compared. For subject 1, where there was no return-to-baseline condition, only the *F* test (baseline-treatment) was of concern. If hypothesis 4 (When the treatment programme is withdrawn for the non-dominant arm and torso of subjects 2 and 3, their activity levels will be significantly higher than they were during the treatment phase of the programme) was valid, a significant *F* would be found when comparing the treatment with the return-to-baseline phase, but not when comparing baseline with return-to-baseline conditions. If hypothesis 3 (The activity level of the dominant arm of each subject will not alter significantly throughout the programme) was valid, the overall *F* (baseline-treatment-return to baseline) in the analysis of variance for the dominant arm of each subject would not be significant.

In testing hypotheses 1, 2, 3, and 4, the regression lines for each of the baseline, treatment, and return-to-baseline phases of the programme were examined to ensure that significant changes in slope and direction of the regression lines of the data were not overlooked. If, for example, the analysis of variance demonstrated no significant differences between two or three phases of a programme, but the regression analysis indicated that the

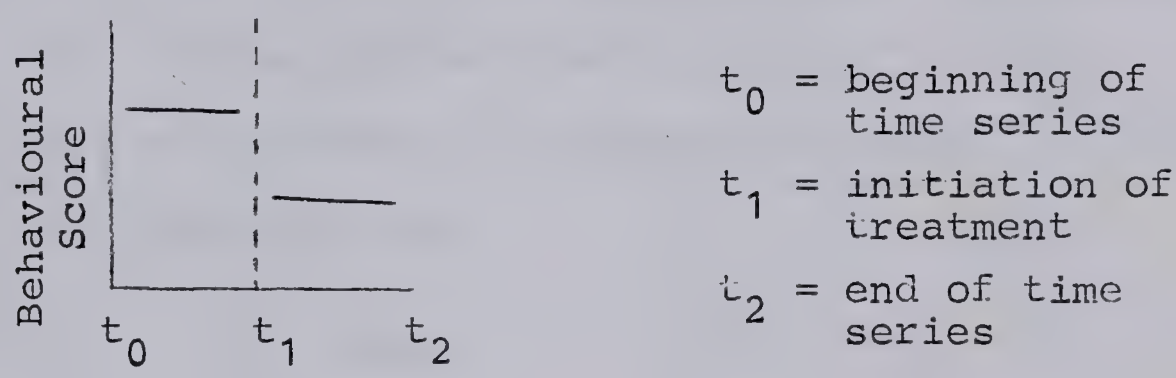
slopes of the 2 or 3 lines were significantly different from one another, then a conclusion of significant treatment effects would be in order. The graphic presentation of the data (for example, see Figure 2a) would have to be examined in light of the findings of the two statistical tests to unambiguously interpret the possible significance of the results.

On the other hand, if the analysis of variance did conclude that there was a significant difference between sets of data and the regression analysis indicated that the slopes of the two lines were not significantly different from one another, the graphic presentation of the data would readily tell whether those results meant a significant treatment effect as exemplified by Figure 2b, or an insignificant treatment effect as exemplified by Figure 2c. Thus, all three means of data interpretation (graphic, analysis of variance, and regression analysis) must be considered in light of one another so that accurate, unambiguous conclusions might be drawn.



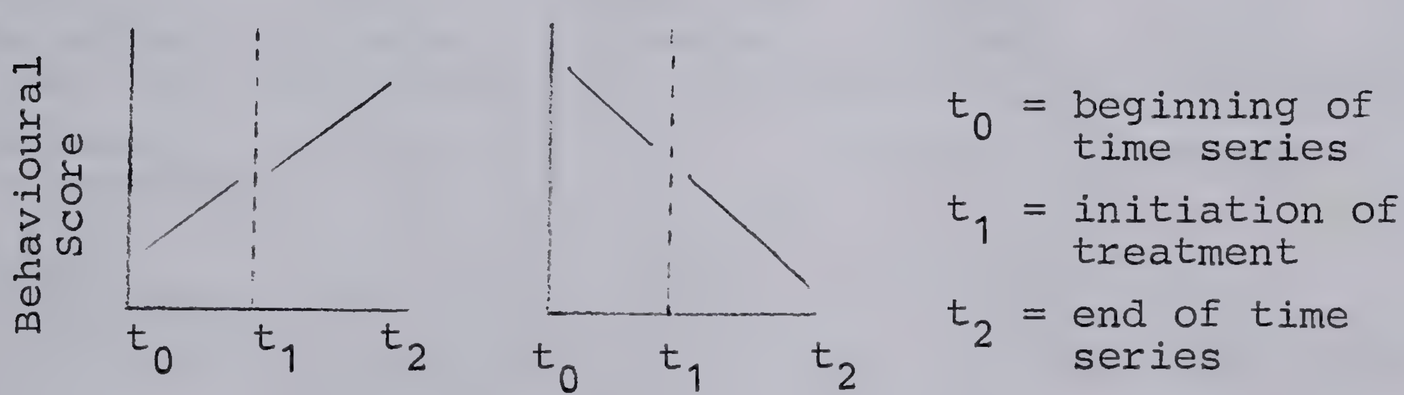
Time series behavioural recordings indicating a significant treatment effect with nonsignificant $\underline{F}$ in analysis of variance results but significant $\underline{F}$ in regression analysis results.

Figure 2a



Time series behavioural recordings indicating a significant treatment effect with a significant $\underline{F}$ in analysis of variance results but a non-significant $\underline{F}$ in regression analysis results.

Figure 2b



Time series behavioural recordings indicating a non-significant treatment effect with a significant $\underline{F}$ in analysis of variance results but a non-significant $\underline{F}$ in regression analysis results.

Figure 2c

Results

<u>Subject 1, Hypothesis 1</u>. The activity level of the non-dominant arm of each subject will be significantly lower during the treatment phase of the program than it was during the baseline phase.

The analysis of variance of the activity level means for subject 1's non-dominant arm is summarized in Table 3. These results demonstrate that as predicted, with subject 1, the activity level of the non-dominant arm was significantly lower ($p < .01$) during the treatment phase ($\overline{X} = 10.64$, $SD = 6.35$) than it was during the baseline phase ($\overline{X} = 24.26$, $SD = 14.97$) of the programme.

Table 3

Summary of Analysis of Variance of Activity Level Means Across Conditions

Subject 1: Non-Dominant Arm

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F	Probability Level
Between Conditions	3012.14	1	3012.14	20.957	$p < .01$
Within Conditions	9198.72	64	143.73		
Total	12210.86	65			

Furthermore, the homogeneity of regression slope analysis (Table 4) demonstrates that there was a significant difference between the slopes of the baseline and

treatment data (p < .05). An examination of the graphically presented data (Figure 3) confirms that the regression analysis and analysis of variance results indicate that the treatment programme was in fact effective for subject 1's non-dominant arm.

Table 4

Summary of Homogeneity of

Regression Slope Analysis

Subject 1: Non-Dominant Arm

Condition	N	B_0	R. Sq.	B_1	DF	F	Probability Level
Baseline	37	10.39	.28	.73			
Treatment	29	9.98	.0	.04	1,62	6.59	$.05 > p > .01$

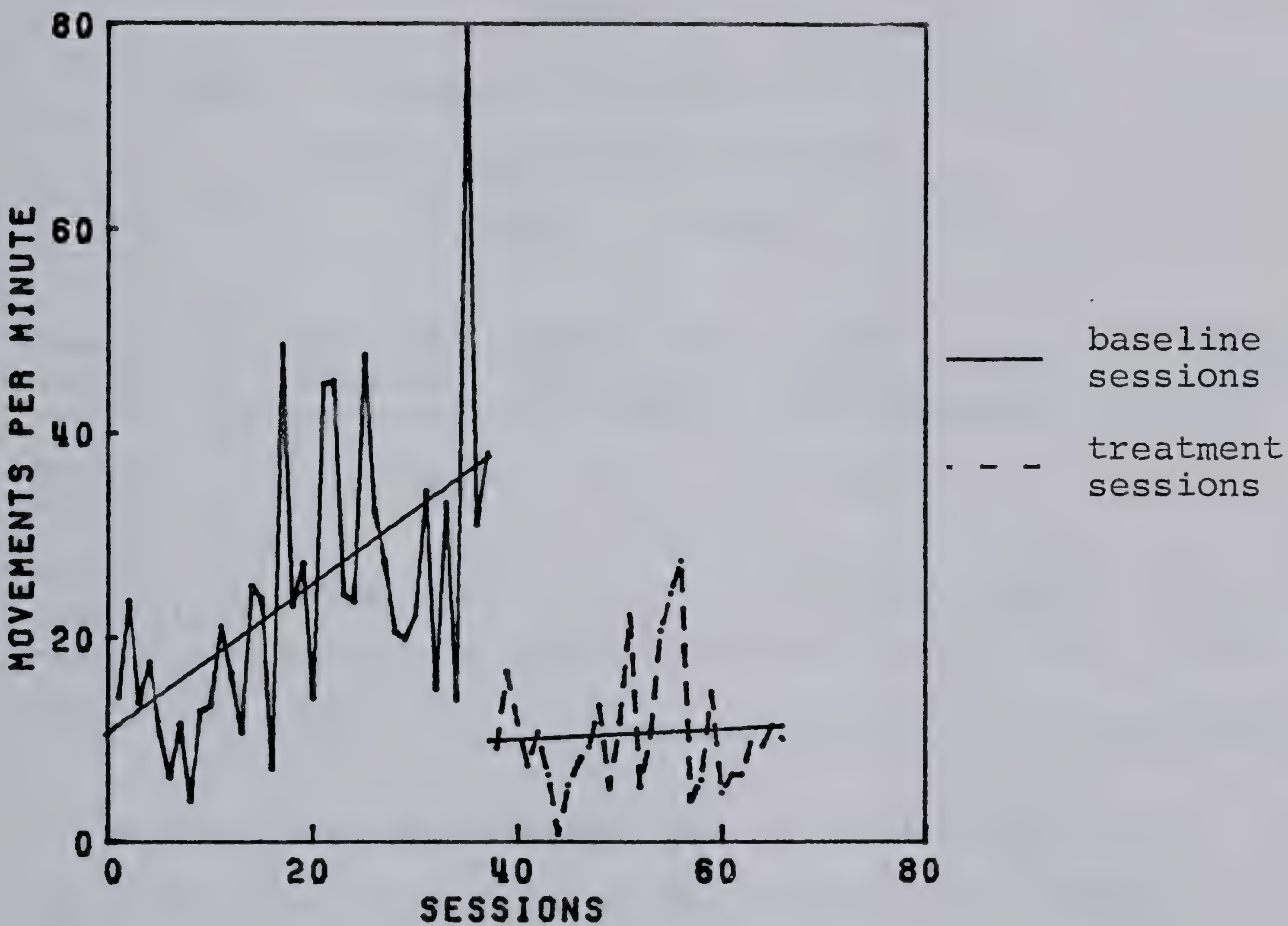


Figure 3. Baseline and treatment activity levels for subject 1: non-dominant arm.

<u>Subject 1, Hypothesis 2</u>. The activity level of the torso of each subject will be significantly lower during the treatment phase of the programme than it was during the baseline phase.

The analysis of variance of activity level means for subject 1's torso is summarized in Table 5.

Table 5

Summary of Analysis of Variance of Activity Level Means Across Conditions

Subject 1: Torso

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	*F*	Probability Level
Between Conditions	752.085	1	752.085		
Within Conditions	8788.976	57	154.193	4.878	$.01 < p < .05$
Total	9541.061	58			

These results indicate that as predicted, the activity level of the torso was significantly lower ($p < .05$) during the treatment phase of the programme ($\overline{X} = 20.98$, $SD = 13.53$) than it was during the baseline phase ($\overline{X} = 28.12$, $SD = 11.24$). Furthermore, the homogeneity of regression slope analysis (Table 6) indicates no significant difference between the baseline and treatment regression slopes and examination of the graphically portrayed data (Figure 4) confirms that the

treatment activity levels were indeed significantly lower than the baseline activity levels.

Table 6

Summary of Homogeneity of

Regression Slope Analysis

Subject 1: Torso

Condition	N	B_0	R.Sq.	B_1	DF	F	Probability Level
Baseline	30	25.24	.02	.19			
Treatment	29	17.75	.02	.23	1,55	.013	$p > .05$

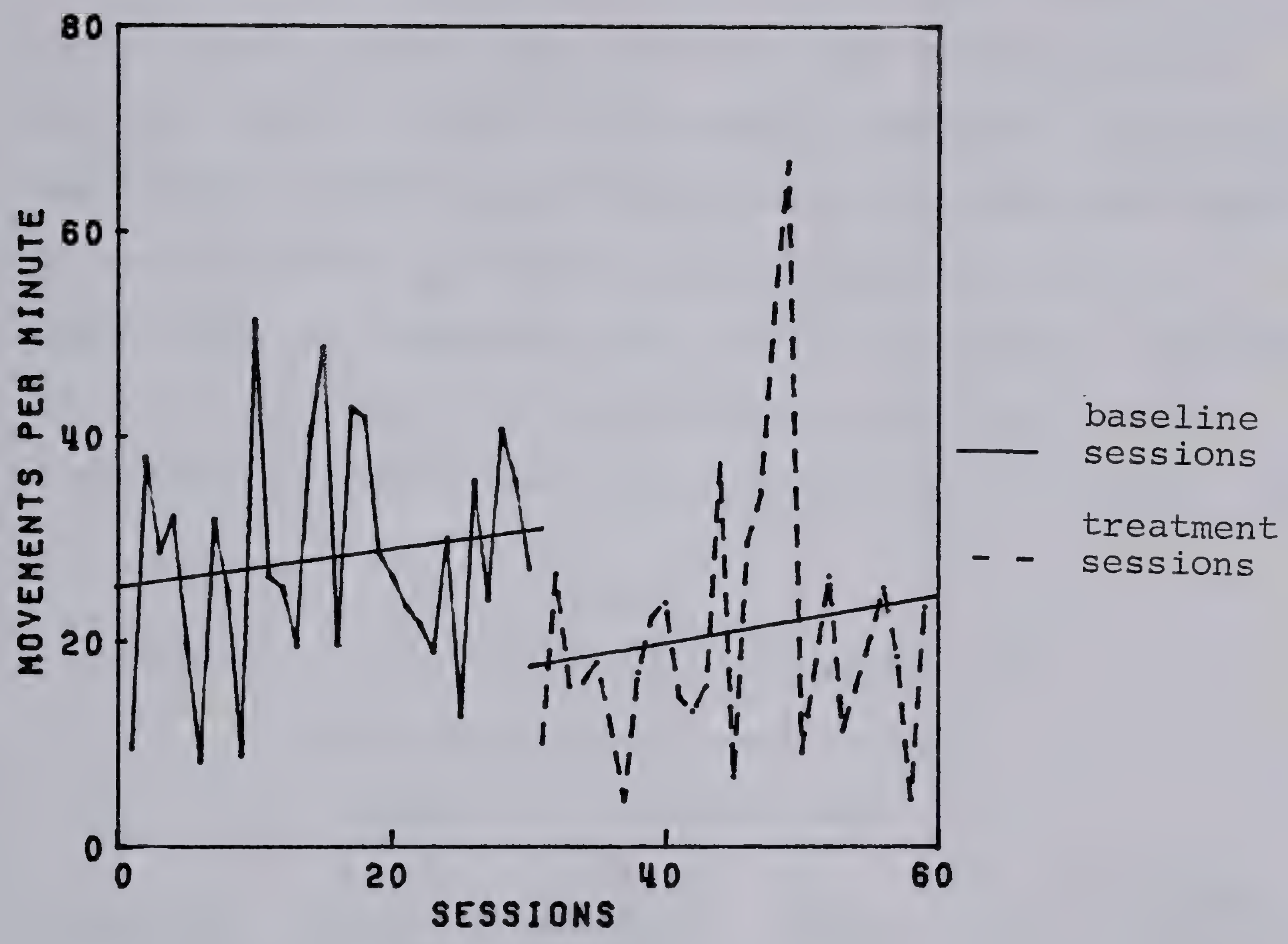


Figure 4. Baseline and treatment activity levels for subject 1: torso.

Subject 1, Hypothesis 3. The activity level of the dominant arm of subject 1 will not alter significantly throughout the program.

The analysis of variance summary for subject 1's dominant arm (Table 7) indicates that as hypothesized, the treatment for the non-dominant arm and torso did not significantly affect the activity level of the dominant arm ($p > .05$). The activity level of subject 1's dominant arm was not significantly lower during the treatment phase of the programme ($\overline{X} = 28.54$, $SD = 14.45$) than it was during the baseline phase ($\overline{X} = 35.75$, $SD = 15.60$). However, it should be noted that the difference was very close to statistical significance ($F_{(obtained)} = 3.702$, $F_{.05} = 3.99$).

Table 7

Summary of Analysis of Variance of Activity Level Means Across Conditions

Subject 1: Dominant Arm

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F	Probability Level
Between Conditions	854.091	1	845.091		
Within Conditions	14608.304	64	228.255	3.7024	$p > .05$ ($F_{.05}=3.99$)
Total	15453.395	65			

That there was no significant difference between the slopes of the treatment and baseline regression lines

(Table 8) appears to further confirm that there was no significant treatment effect for subject 1's dominant arm. However, an examination of the graphically presented data (Figure 5) shows that while baseline and treatment mean activity levels and regression line slopes were not significantly different from one another, the treatment programme did, in fact, have a substantial effect. Throughout the baseline sessions, activity level was gradually increasing. When treatment was initiated for the non-dominant arm and torso, the activity level of the dominant arm decreased dramatically and then proceeded to increase slightly. If the treatment programme had had no effect, the upward trend in activity level of the baseline period would have been expected to continue upward, resulting in a significant overall F.

Table 8

Summary of Homogeneity of
Regression Slope Analysis
Subject 1: Dominant Arm

Condition	N	B_0	R.Sq.	B_1	DF	F	Probability Level
Baseline	37	27.15	.10	.45			
Treatment	29	26.04	.01	.19	1,62	.53	$p > .05$

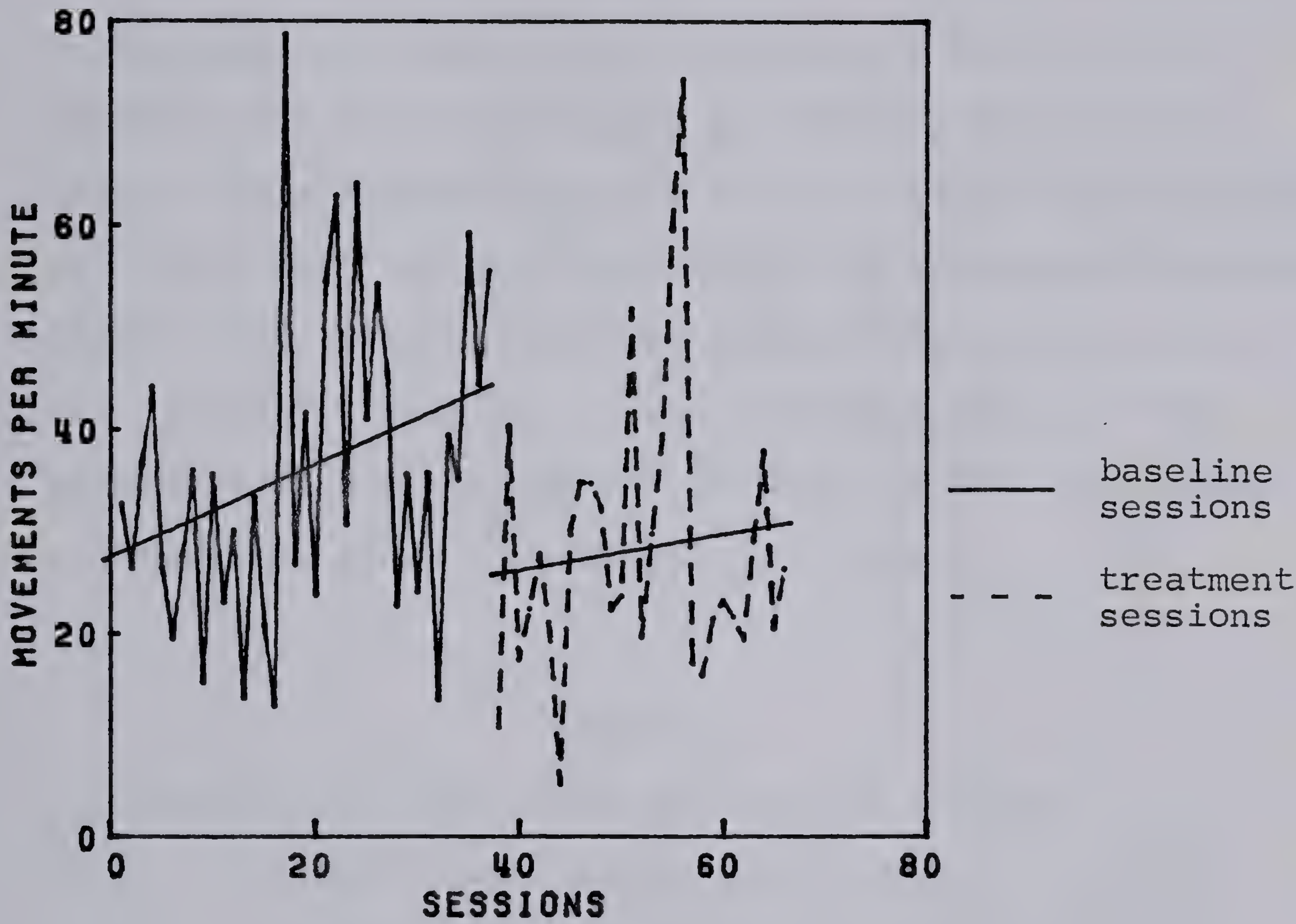


Figure 5. Baseline and treatment activity levels for subject 1: dominant arm.

Subject 2, Hypothesis 1. The activity level of the non-dominant arm of each subject will be significantly lower during the treatment phase of the programme than it was during the baseline phase.

The summary of the analysis of variance of activity level means for subject 2's non-dominant arm (Table 9) demonstrates that contrary to prediction, the activity level of the non-dominant arm did not reduce significantly ($p > .05$) with the introduction of the treatment programme. In fact the activity level of subject 2's non-domiant arm was somewhat higher during the treatment phase of the programme ($\overline{X} = 31.88$, $SD = 8.30$) than it had been during the baseline phase ($\overline{X} = 29.32$, $SD = 9.08$).

Table 9

Summary of Analysis of Variance of Activity Level Means Across Conditions

Subject 2: Non-Dominant Arm

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F	Probability Level
Between Conditions	185.125	2	92.56		
Within Conditions	6398.125	80	79.98	1.16	$p = .3195$
Total	6583.25	82			

Even though there was no significant difference between the regression slopes of the baseline and treatment activity levels (Table 10), an examination of the graphed data (Figure 5) demonstrates that treatment did indeed have an effect, although certainly not the effect predicted. Activity level of the non-dominant arm was steadily decreasing throughout the baseline period. Upon initiation of the feedback and reward programme, the non-dominant arm's activity level rose to its original level and then proceeded to decrease again.

Table 10

Summary of Homogeneity of Regression Slope Analysis

Subject 2: Non-Dominant Arm

Condition	N	B_0	R.Sq.	B_1	DF	F	Probability Level
Baseline	28	36.16	.18	-.47			
Treatment	37	35.24	.06	-.19			
Return to Baseline	18	31.33	.18	.18	2,77	1.297	$p > .05$

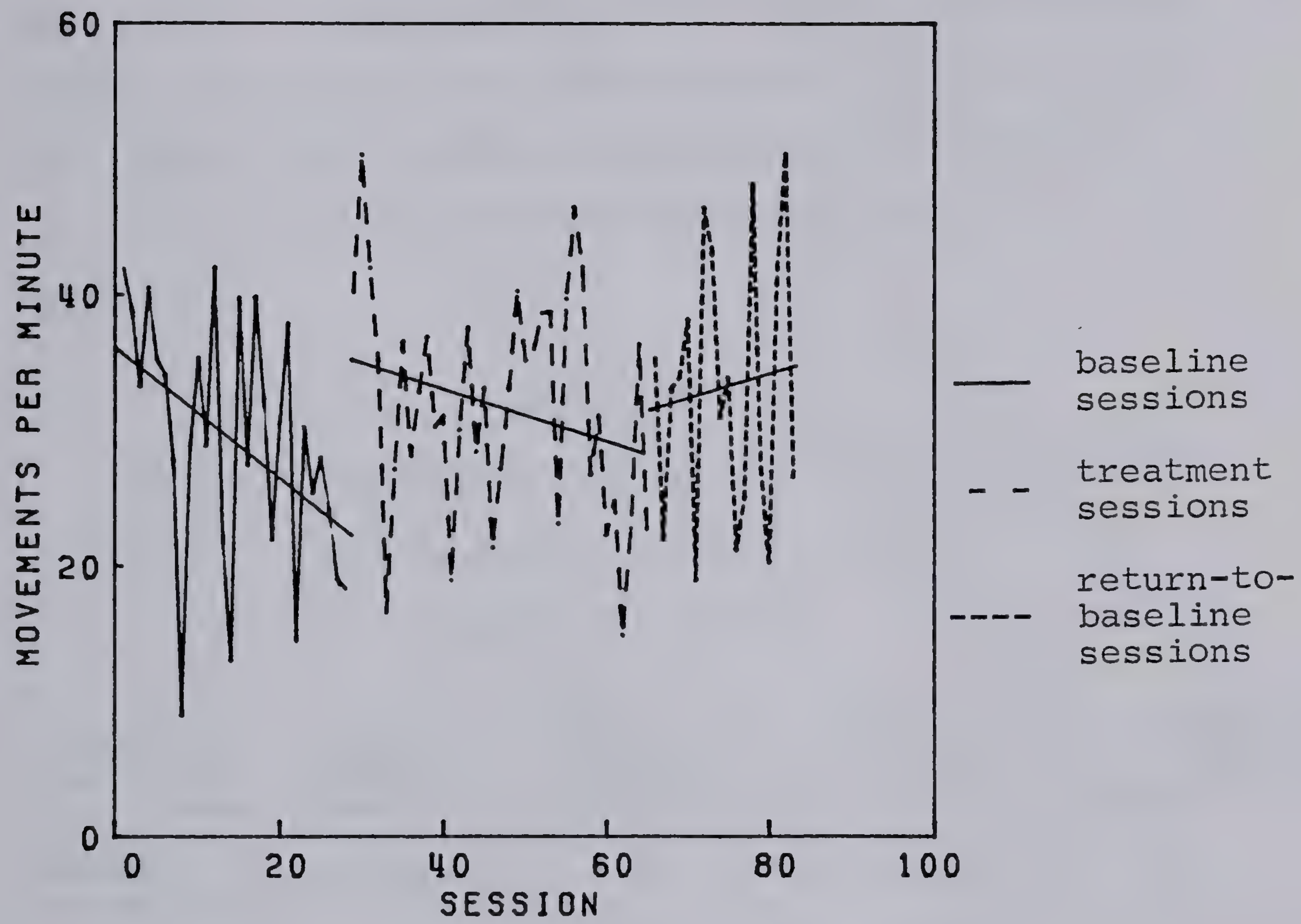


Figure 6. Baseline, treatment and return-to-baseline activity levels for subject 2: non-dominant arm.

Subject 2, Hypothesis 2. The activity level of the torso of each subject will be significantly lower during the treatment phase of the programme than it was during the baseline phase.

Table 11 shows that a very significant treatment effect was evident in the data from subject 2's torso ($p < .001$). The Scheffé multiple comparisons summary (Table 12) indicates that the treatment activity level ($\bar{X} = 28.11$, $SD = 8.95$) was significantly different ($p < .001$) from the baseline activity level ($\bar{X} = 93.11$, $SD = 8.95$).

Table 11

Summary of Analysis of Variance of Activity Level Means Across Conditions

Subject 2: Torso

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F	Probability Level
Between conditions	77813.875	2	38659.44		
Within conditions	57678.813	80	720.99	53.63	p=.000001
Total	134997.688	82			

Table 12

Summary of Scheffé Multiple Comparisons

Subject 2: Torso

Comparison	Mean Difference Squared	Standard Error	DF_1	DF_2	F	p
baseline-treatment	4225.066	90.471	2	80	46.70	0.000
baseline-return to baseline	4045.625	131.608	2	80	30.74	0.000
treatment-return to baseline	1.947	119.082	2	80	0.02	0.984

The regression analysis (Table 13) indicates that the slopes of subject 2's baseline and treatment activity levels differ significantly. As well, an examination of the plotted data (Figure 7) confirms that the treatment programme indeed had a very significant effect in the predicted direction on the activity level of subject 2's torso.

Table 13

Summary of Homogeneity of Regression Slope Analysis

Subject 2: Torso

Condition	N	B_0	R.Sq.	B_1	DF	F	Probability Level
Baseline	28	73.47	.06	1.35			
Treatment	37	30.08	.02	-.10			
Return to Baseline	18	33.67	.04	-.48	2,77	2.139	$p > .05$

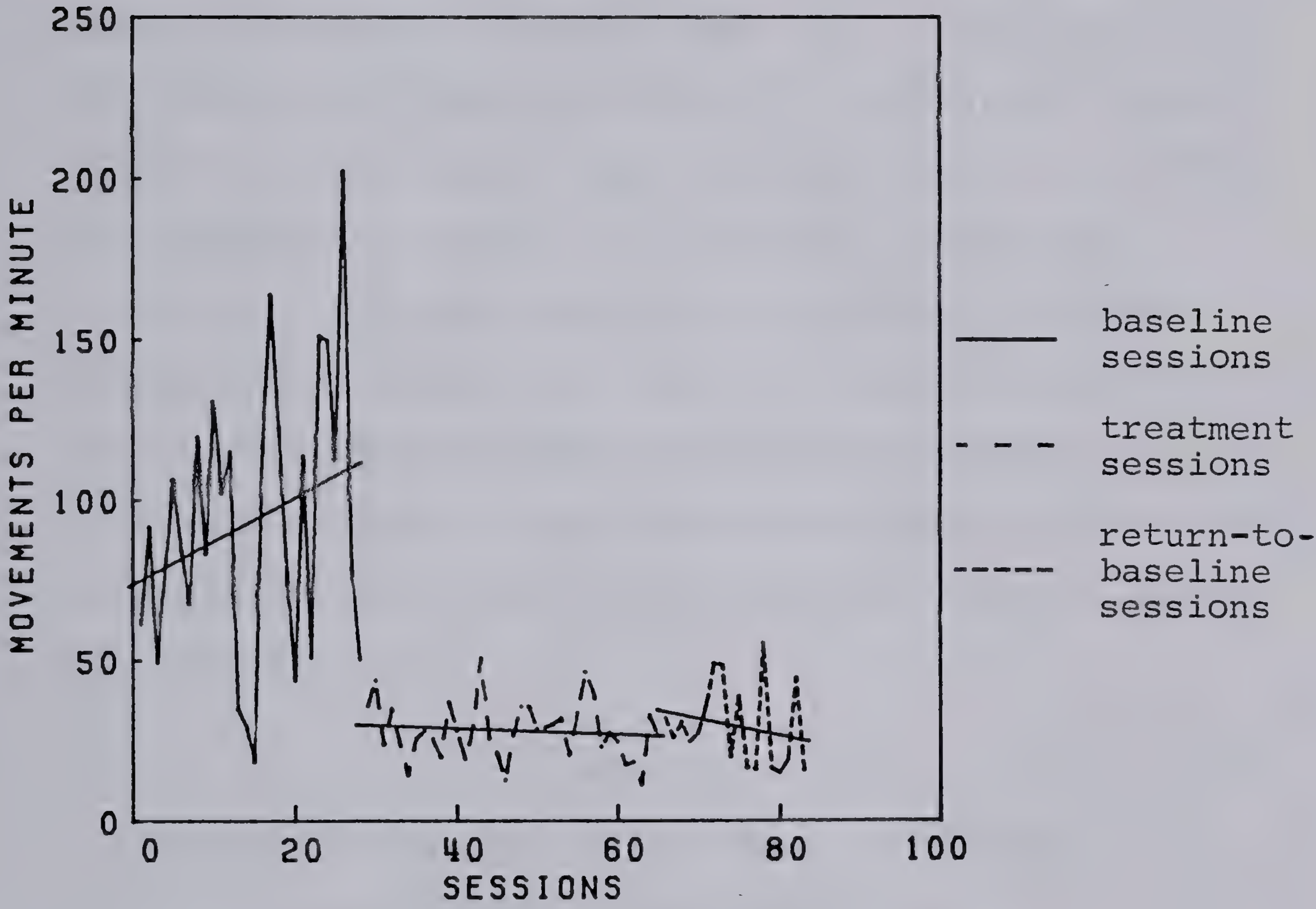


Figure 7. Baseline, treatment and return-to-baseline activity levels for subject 2: torso.

Subject 2, Hypothesis 3. The activity level of each subject's dominant arm will not alter significantly throughout the programme.

Table 14 indicates that the activity level of subject 2's dominant arm, contrary to the prediction, demonstrated a very significant treatment effect ($p < .001$). Table 15 demonstrates that activity level was significantly lower during the treatment phase ($\bar{X} = 41.34$, $SD = 9.79$) than during the baseline phase ($\bar{X} = 145.80$, $SD = 69.89$) of the programme ($p < .001$). As well, as with the data from subject 2's torso, the baseline regression line (Table 16) was significantly different from the treatment regression line ($p < .01$), and examination of the graphically presented data (Figure 7) further confirms that treatment received by the non-dominant arm and torso had a very significant effect on the activity level of subject 2's dominant arm.

Table 14

Summary of Analysis of Variance of Activity Level Means Across Conditions

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	*F*	Probability Level
Between conditions	177584.009	2	88792.004		
Within conditions	118691.437	77	1541.447	57.60	$p=.000001$
Total	296275.446	79			

Table 15

Summary of Scheffé Multiple Comparisons

Subject 2: Dominant Arm

Comparison	Mean Difference Squared	Standard Error	DF_1	DF_2	F	p
baseline-treatment		206.638	2	77	52.80	0.000
baseline-return to baseline	9007.457	264.588	2	77	30.58	0.000
treatment-return to baseline	91.163	254.594	2	77	.36	0.700

Table 16

Summary of Homogeneity of

Regression Slope Analysis

Subject 2: Dominant Arm

Condition	N	B_0	R.Sq.	B_1	DF	F	Probability Level
Baseline	25	75.98	.34	5.37			
Treatment	37	37.79	.05	.20			
Return to Baseline	18	49.74	.0	.17	2,74	12.46	$p < .01$

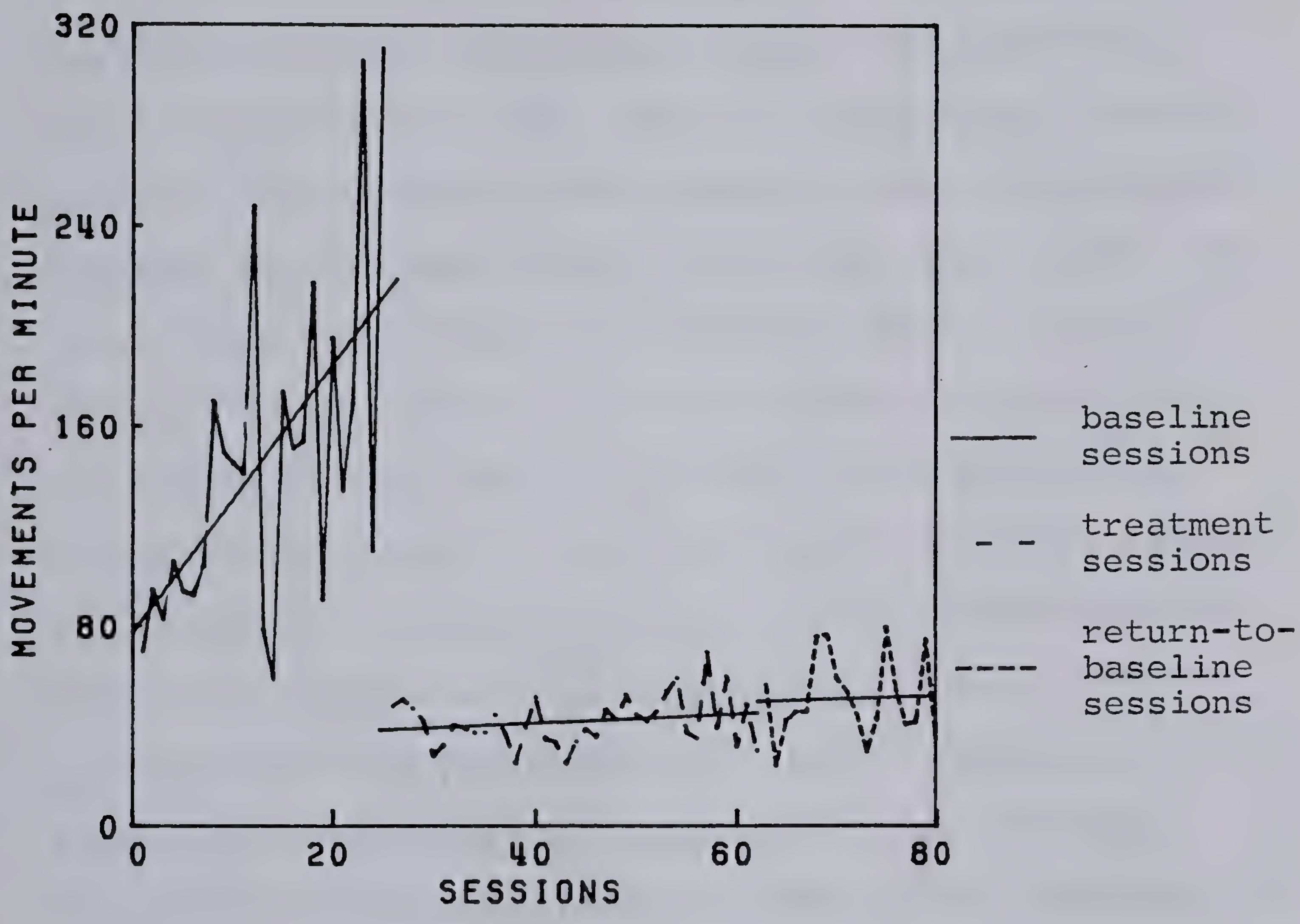


Figure 8. Baseline, treatment, and return-to-baseline activity levels for subject 2: dominant arm.

Subject 2, Hypothesis 4. When the treatment programme is withdrawn for the non-dominant arm and torso of Subjects 2 and 3, the activity levels of these body parts will be significantly higher than they had been during the treatment phase of the programme.

An examination of the analysis of variance (Table 11) and Scheffé (Table 12) summary tables for subject 2's torso indicates that when the reinforcement and feedback programme was withdrawn, the activity level of the torso remained significantly lower ($\overline{X}$ = 29.50, SD = 13.10) than it had been during the baseline phase of the programme ($\overline{X}$ = 93.11, SD = 43.83). In other words, the torso did not return to its baseline activity level as had been predicted ($p < .001$). While the torso's activity level did increase slightly, it was not significantly different than it had been during the treatment phase ($\overline{X}$ = 28.11, SD = 8.95) of the programme ($p = .984$). Furthermore, the slopes of the regression lines for subject 2's torso (Table 13) did not change significantly from treatment to return-to-baseline phases and the graphed data (Figure 7) further confirms that this experiment was not successful in returning activity rates to their pre-treatment levels.

While treatment of the non-dominant arm did not have its predicted effect, when the treatment programme was withdrawn, the activity level of the non-dominant arm did increase (Figure 6). Although the means of the treatment ($\overline{X}$ = 31.38, SD = 8.30) and return-to-baseline ($\overline{X}$ = 33.17,

SD = 9.96) phases were not significantly different from one another (Table 9), the downward trend observed during the treatment phase changed to an upward trend in activity level when the rewards and feedback were removed. Due to the great variability in activity level, however, the slopes of the regression lines for this subject's non-dominant arm are not statistically different from one another (Table 10).

While the original hypothesis 4 involved the non-dominant arm and torso, because subject 2's dominant arm demonstrated significant treatment effects, it seems appropriate to examine whether or not, when the treatment programme was withdrawn, subject 2's dominant arm activity level returned to its previous baseline rate. An examination of the analysis of variance (Table 14) and Scheffé (Table 15) summary tables for subject 2's dominant arm, indicates that when the treatment programme was withdrawn, the dominant arm activity level ($\bar{X}$ = 50.89, SD = 16.47) remained lower than it had been during the baseline period ($\bar{X}$ = 145.80, SD = 67.89). The dominant arm, like the torso, did not return to its baseline activity level ($p < .001$). Furthermore, the treatment regression line slope was not significantly different than the return-to-baseline regression line slope (Table 16) and the graphed data (Figure 8) confirms that subject 2's dominant arm did not return to its baseline level once the treatment programme for the non-dominant arm and torso was removed.

Subject 3, Hypothesis 1. The activity level of each subject's non-dominant arm will be significantly lower during the treatment phase of the programme than it was during the baseline phase.

Results from the analysis of variance summary (Table 17) suggest that there was a significant difference in activity level across conditions for subject 3's non-dominant arm ($p < .001$) and the Scheffé test (Table 18) demonstrates that in particular, the activity level during the treatment phase ($\bar{X} = 10.74$, $SD = 9.19$) of the programme was significantly lower ($p < .001$) than it had been during the baseline phase ($\bar{X} = 20.45$, $SD = 7.40$).

Table 17

Summary of Analysis of Variance of Activity Level Means Across Conditions Subject 3: Non-Dominant Arm

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F	Probability Level
Between Conditions	1565.477	2	782.74		
Within Conditions	6626.926	78	84.96	9.21	$p=.000256$
Total	8192.403	80			

Table 18

Summary of Scheffé Multiple Comparisons

Subject 3: Non-Dominant Arm

Comparison	Mean Difference Squared	Standard Error	DF_1	DF_2	F	p
baseline-treatment	103.326	11.8	2	78	8.76	.000
baseline-return to baseline	69.425	15.172	2	78	4.58	.013
treatment-return to baseline	3.359	12.812	2	78	.26	.770

The regression slope analysis (Table 19) demonstrates that there was no significant difference in the slopes of the regression lines for subject 3's non-dominant arm across conditions and the plot of the data (Figure 9) confirms that a change in level of the activity rates is the primary source of the significant differences in the means between the baseline and treatment phases of the programme.

Table 19

Summary of Regression Slope Analysis

Subject 3: Non-Dominant Arm

Condition	N	B_0	R.Sq.	B_1	DF	F	Probability Level
Baseline	24	21.04	.0	-.01			
Treatment	36	12.53	.01	-.09			
Return to Baseline	21	10.9	.01	.19	2,75	.29	$p > .05$

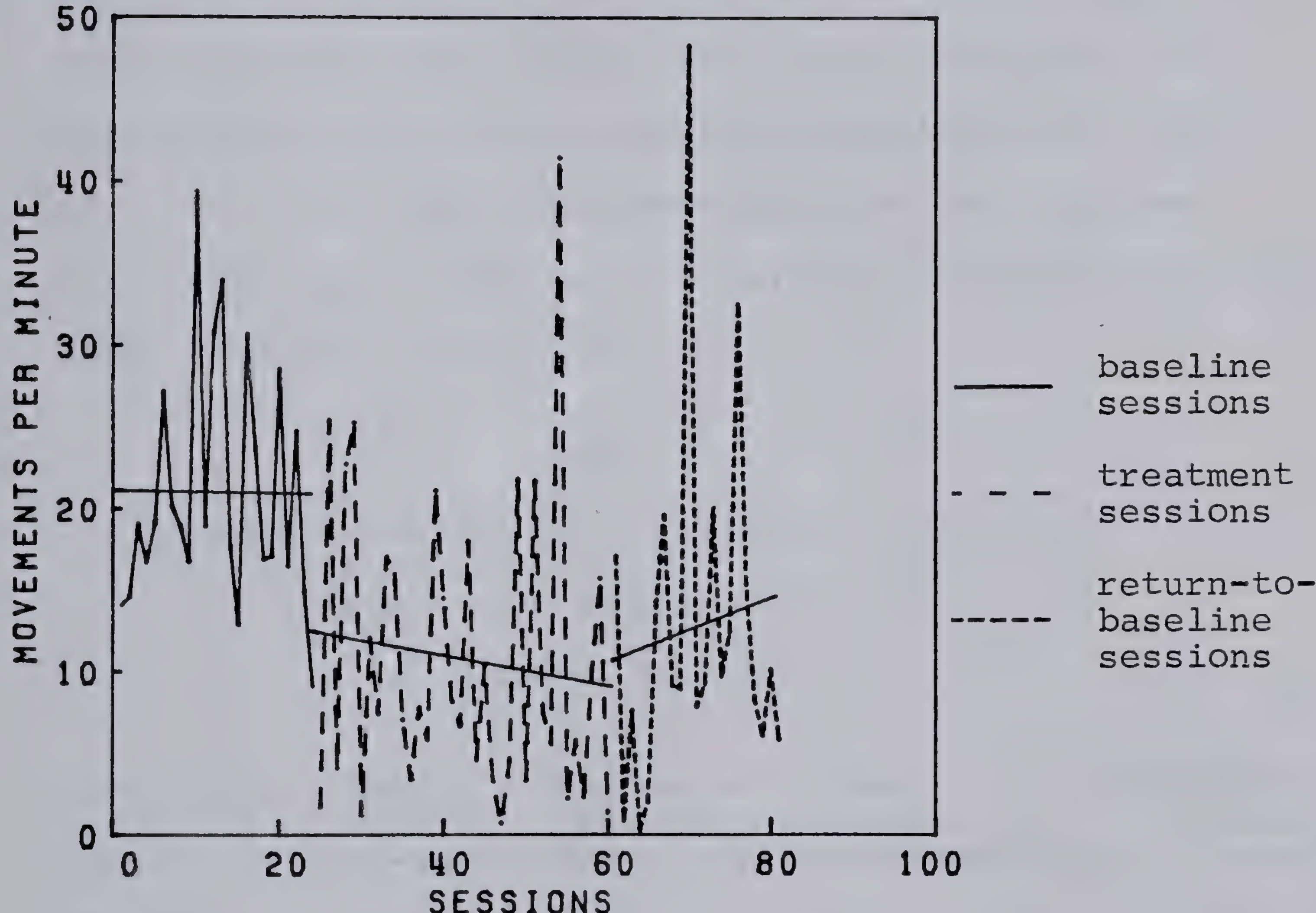


Figure 9. Baseline, treatment and return-to-baseline activity levels for subject 3: non-dominant arm.

Subject 3, Hypothesis 2. The activity level of each subject's torso will be significantly lower during the treatment phase of the programme than it was during the baseline phase.

The results from the analysis of variance summary for subject 3's torso (Table 20) indicates a significant difference in activity level across conditions ($p < .01$) and the Scheffé test (Table 21) demonstrates that, in particular, the activity level was significantly lower ($p < .01$) during the treatment phase of the programme ($\bar{X} = 1.56$, $SD = 1.66$) than it had been during the baseline phase ($\bar{X} = 2.75$, $SD = 1.13$).

Table 20

Summary of Analysis of Variance of Activity Level Means Across Conditions

Subject 3: Torso

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F	Probability Level
Between Conditions	22.316	2	11.16		
Within Conditions	158.815	79	2.01	5.55	p=.0056
Total	181.131	81			

Table 21

Summary of Scheffé Multiple Comparisons

Subject 3: Torso

Comparison	Mean Difference Squared	Standard Error	DF_1	DF_2	F	p
baseline-treatment	1.436	0.279	2	79	5.14	0.008
baseline-return to treatment	1.077	0.350	2	79	3.07	0.052
treatment-return to baseline	0.026	0.294	2	79	0.09	0.916

The lack of a significant difference in the slopes of the regression lines across conditions ($p > .05$, Table 22) as well as the pattern of activity levels evident in the plot of this data (Figure 10) confirms that it is the change in level of activity rates between the baseline and treatment sessions that contributes primarily to the significant overall F of the analysis of variance and the significant F between conditions 1 and 2 in the Scheffé test.

Table 22

Summary of Regression Slope Analysis

Subject 3: Torso

Conditions	N	B_0	R.Sq.	B_1	DF	F	Probability Level
Baseline	24	2.82	.0	-.0			
Treatment	36	1.6	.0	-.0			
Return to Baseline	22	1.86	.0	-.0	2,75	.021	$p > .05$

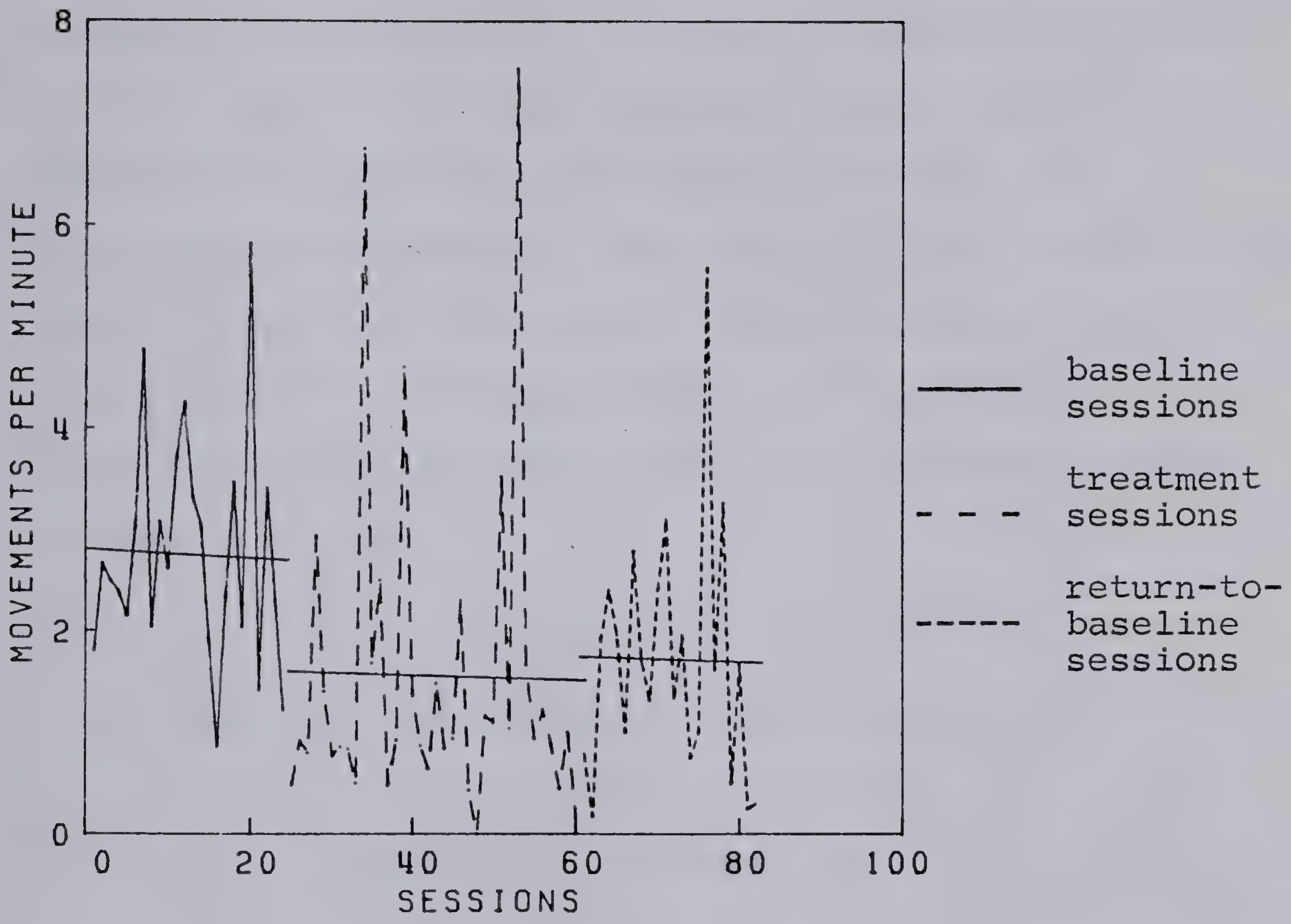


Figure 10. Baseline, treatment and return-to-baseline activity levels for subject 3: torso.

<u>Subject 3, Hypothesis 3</u>. The activity level of each subject's dominant arm will not alter significantly throughout the programme.

Upon examination of the analysis of variance summary (Table 23) and the summary of the Scheffé multiple comparison analysis (Table 24) for subject 3's dominant arm, it is tempting to conclude that, contrary to prediction, when the treatment for the non-dominant arm and torso was initiated the activity level of the dominant arm decreased significantly. The overall <u>F</u> had a probability level of less than .05 and the Scheffé between baseline conditions ($\overline{X}$ = 13.07, <u>SD</u> = 5.99) and treatment conditions ($\overline{X}$ = 8.04, <u>SD</u> = 7.84) had a probability level of less than .05.

Table 23

Summary of Analysis of Variance of Activity Level Means Across Conditions

Subject 3: Dominant Arm

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	<u>F</u>	Probability Level
Between Conditions	377.539	2	188.77		
Within Conditions	4311.352	79	54.57	3.46	p=.0363
Total	4688.891	81			

Table 24

Summary of Scheffé Multiple Comparisons

Subject 3: Dominant Arm

Comparison	Mean Difference Squared	Standard Error	DF_1	DF_2	F	p
baseline-treatment	25.265	7.580	2	79	3.33	0.041
baseline-return to baseline	15.519	9.509	2	79	1.63	0.202
treatment-return to baseline	1.182	7.993	2	79	0.15	0.863

However, it can be seen from the regression slope analysis (Table 25) that both baseline activity levels' and treatment activity levels' regression lines have a slight negative slope which are not significantly different from one another ($p > .05$).

Table 25

Summary of Homogeneity of

Regression Slope Analysis

Subject 3: Dominant Arm

Condition	N	B_0	R.Sq.	B_1	DF	F	Probability Level
Baseline	24	14.03	.01	-.08			
Treatment	36	10.26	.03	-.12			
Return to Baseline	22	9.98	.0	-.07	2,72	.027	$p > .05$

Furthermore, the graphed data (Figure 11) suggests that the difference found by the analysis of variance and Scheffé is primarily due to the continuing negative slope of those regression lines and only to a lesser extent due to a minimal change in level from baseline to treatment phases of the programme. It can be concluded then, that while the treatment programme for the non-dominant arm and torso did influence the activity level of subject 3's dominant arm, it did not do so significantly.

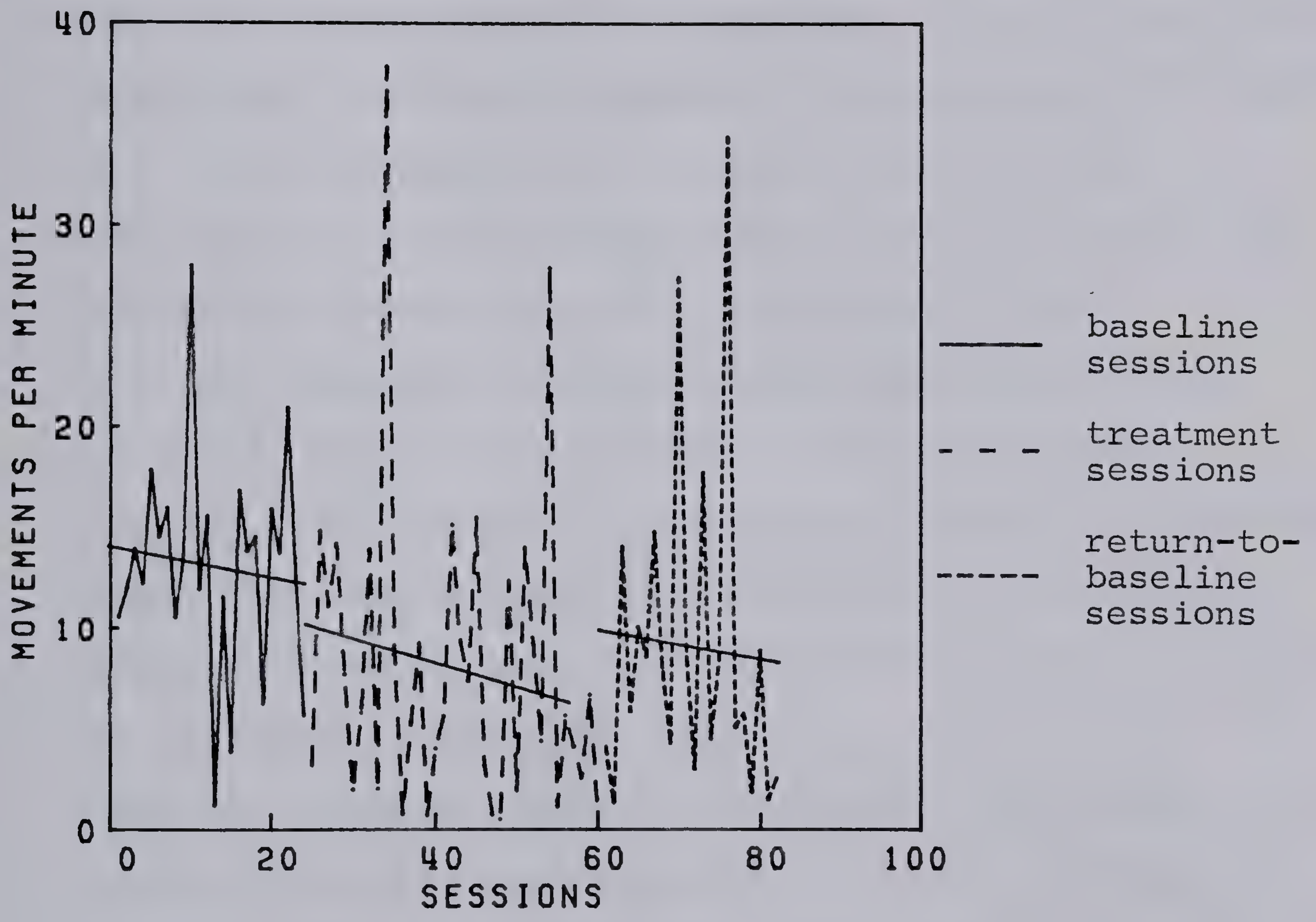


Figure 11. Baseline, treatment and return-to-baseline activity levels for subject 3: dominant arm.

Subject 3, Hypothesis 4. When the treatment programme is withdrawn for the non-dominant arm and torso of subjects 2 and 3, the activity levels of these body parts will be significantly higher than they had been during the treatment phase of the programme.

The Scheffé summary for subject 3's non-dominant arm (Table 18) demonstrates that the activity level remained significantly lower ($p < .05$) during the return-to-baseline phase of the programme ($\overline{X} = 12.62$, $SD = 10.98$) than it had been during the baseline phase of the programme ($\overline{X} = 20.95$, $SD = 7.40$). The return-to-baseline activity level, in fact, was not significantly different ($p = .770$) than the treatment activity level ($\overline{X} = 10.79$, $SD = 9.19$).

Upon examination of the non-dominant arm plot for subject 3 (Figure 9) it became evident that while activity level was on a slight decline during the treatment phase, there was a shift to a gradual increase during the return-to-baseline phase of the programme. This change in the regression lines (from a slope of -.09 to .19; Table 19), however, was not statistically significant. One can conclude then, that the removal of the treatment did have some effect, although not a statistically significant one, on the activity level of subject 3's non-dominant arm in the predicted direction.

The Scheffé summary for subject 3's torso (Table 21) indicates that the activity level of this subject's torso remained significantly lower ($p = .05$) during the return-to-baseline phase of the programme ($\overline{X} = 1.72$,

SD = 1.25) than it had been during the baseline phase of the programme ($\bar{X}$ = 2.75, SD = 1.13). In fact, the return-to-baseline activity level was not significantly different (p = .916) than the treatment activity level ($\bar{X}$ = 1.56, SD = 1.66).

An examination of the graphically presented data for subject 3's torso (Figure 10) demonstrates that the level of the treatment and return-to-baseline regression lines were only slightly different from one another. The regression analysis (Table 22) informs us that there is no significant difference (p > .05) in the slopes of the two regression lines. Both of these observations confirm that hypothesis 4 is not valid for subject 3's torso data.

It is interesting to note, as well, that even though the Scheffé (Table 24) appears to demonstrate that the activity level of the dominant arm returned to its baseline level or was at least not significantly lower than it had been during the baseline phase (p = .202), it can be seen from the dominant arm's activity level plot, that with the removal of reinforcement and feedback, activity level increased initially and then continued on a downward trend.

Summary of Hypothesis Testing

$\underline{H}_1$. With two out of the three subjects, the activity level of the non-dominant arm was significantly lower during the treatment phase of the programme than it was during the baseline phase.

$\underline{H}_2$. In all three cases, the activity level of the torso was significantly lower during the treatment phase of the programme than it was during the baseline phase.

$\underline{H}_3$. In no case was the activity level of the dominant arm unaffected by the introduction of the treatment programme for the non-dominant arm and torso. However, with subject 3, the significant difference between baseline and treatment activity levels was primarily due to a continuing decline in activity level, with no significant change in rate or level of decline between the baseline and treatment sessions.

$\underline{H}_4$. With neither of the two subjects in which a return-to-baseline condition was used did activity rates return to their baseline levels or even increase significantly when the reinforcement and feedback programmes were removed. However, with the non-dominant arms of both subject 3 and subject 2, a slight downward trend in treatment phase activity level changed to an upward trend during the return-to-baseline phase of the programme. Due to the great variability in the data, though, these slope changes were not statistically significant.

Discussion

Anomalous Results

1. The results from subject 2 seemed quite contrary to what was expected. He lowered the activity level of his dominant arm for which he had received neither feedback nor contingent reinforcement, while he did not significantly lower the activity level of his non-dominant arm for which he had received both. This child, it should be recalled, was the most active of the three subjects. He would move from activity to activity, attempting anything new that appeared on the scene, but only until some other stimulus came to his attention. He appeared to react to the activity monitor in this very way. When he initially put on the shirt, he examined it, attempted to turn it around to gain access to the back-mounted pouch and attempted to pull the mercury switches out of their pockets. He soon tired of this and went on to another activity. When the earphone was put on and feedback initiated he again examined the apparatus and tested out various ways of triggering the tone. While he eventually tired of these activities, he went through this process at least once during every session. While there is no numerical data available relevant to this point, this experimenter, on the basis of frequent observations, concluded that it was likely that if the activity counts which occurred as a result of this subject's "testing"

sessions could be deleted from the cumulative data for his non-dominant arm, a reduction of activity level for the treatment phase of the programme would be evident.

2. It was noted that with two out of three subjects (subject 1 and subject 2) activity level of the dominant arm was significantly affected by treatment given to the non-dominant arm and torso. This would seem to suggest that the assumption that this experimenter made as to the independence of the activity levels of the two arms was not, in all cases, valid. It is quite likely that the activity levels of all parts of an individual's body are usually quite highly intercorrelated. In fact, examination of the baseline activity levels for subjects 1 and 3 indicate that the activity levels of the three different target body parts of these individuals co-varied with one another.

An alternative rationale for the change in activity level of the dominant arms could be based on the principle of response generalization. In a study by Schwartz and Hawkins (1970), a child was videotaped during math class and upon being subsequently shown the video tape, was rewarded on the basis of her behaviour during class It was found that behaviour improved not only in math class, but also in other classes. This experiment demonstrates the principle that delaying reinforcement may make it difficult for the child to discriminate between those behaviours for which he will be rewarded and those for which he will not and thus may lead to response generalization. In the present study the children may have noted that overall reduction of activity led to reinforcement and may not have made the

discrimination between the consequences of activity of each individual body part. While the feedback should have provided the necessary information for this discrimination, the children may have had difficulty distinguishing between those activities which resulted in feedback and those which did not.

3. Why did the treatment activity levels not approximate baseline levels (or even increase at all in many cases) following removal of the treatment programme? The dispensing of rewards only after the children had accumulated a required number of points can be characterized as an intermittent reinforcement schedule (fixed ratio with a shifting criterion). Intermittent reinforcement has been defined as reinforcing some, but not all emissions of a response (Sulzer-Azaroff & Mayer, 1977) and has been found to "generate performance that maintains longer than that generated by a history of CRF (continuous reinforcement)" (Sulzer-Azaroff & Mayer, 1977, p. 335). Furthermore, that the children were given points (stars) at the end of the sessions (delayed reinforcement) and not immediately upon having appropriately responded, would enhance the maintenance of the behaviour (Logan, 1970).

The systematic change in the criteria for earning rewards also affected the schedule of reinforcment in such a way as would be likely to increase the resistence to extinction of the low activity levels. In essence, the reinforcement schedule during treatment becomes less and

less dense, thus making the transition to non-reinforcement during return-to-baseline sessions less apparent and not as likely to lead to an immediate increase in activity level.

The maintenance of low activity levels from the treatment sessions to the return-to-baseline sessions could to some extent be explained by the continuity of factors from the treatment to return-to-baseline sessions. In particular, the children were still wearing the activity monitor shirt in order to monitor their activity levels even after the feedback and reinforcement program was withdrawn. In fact, this shirt, being obviously and uniquely related to treatment may have become a discriminative stimulus (S_D) for low levels of activity. Sulzer-Azaroff and Mayer define an S_D as

> A stimulus in the presence of which a given response is likely to be reinforced. An S_D operates to "occasion" a particular response in that it signals the likelihood of reinforcement. (1977, p. 516)

Furthermore, because delayed reinforcement was associated with wearing the activity monitor jacket, continued wearing of the jacket during return-to-baseline sessions may have provided a signal to the children that they should continue to expect a delayed reinforcer.

It is entirely possible that these children's activity levels increased substantially in situations where they were not wearing these shirts. However, if maintenance brought about by the above-described factors was the only force operating, one would expect that it would take less than

the eighteen to twenty-two return-to-baseline sessions that these children experienced for this conditioned response to begin to extinguish.

The third possible rationale for the failure to return to baseline is that there were other reinforcers of low activity levels present in the environment and that they continued to exist after the experimental treatment ceased to operate and that they served to maintain the learned behaviour. The children's teachers may have been praising the children for their low activity levels. The children's peers may have been providing reinforcement for the lower activity levels as they could have found the target children with their reduced activity levels more cooperative and less bothersome. Finally, the subjects themselves may have found their increased ability to complete classroom work satisfying as well as extrinsically reinforcing (check marks, better grades, and/or praise). This tendency for the contingencies in the child's natural environment to take control of the behaviour has been called "trapping" (Baer & Wolf, 1970; Kazdin, 1977).

If it is true, as was hypothesized, that the feedback provided the subjects with the information necessary for them to reduce their activity levels, then by the time the return-to-baseline sessions began, the subjects could have learned to identify from other, either internal or external cues, what "activity level"

consisted of. This factor, in conjunction with trapping, could have served to maintain low activity levels.

It is clear that there was failure to demonstrate complete experimental control of behaviour in this experiment. The fact that the study was not conducted in a laboratory setting may have resulted in natural contingencies in the subject's environment being responsible at least to some extent for maintaining low activity levels after the treatment programme was withdrawn. While this is not desirable from a purely experimental point of view, it is certainly a psychologically and educationally advantageous situation.

Activity Monitor as a Feedback Device

While the feedback system utilized in this experiment seemed to be quite functional (although because of the experimental design utilized it is not known whether it is valuable in itself or only as an adjunct to a reinforcement programme), it was clear from the beginning of this research project that it would have been preferable if feedback were only provided for overactivity and not all activity. This would have involved designing the monitor so that a specified number of activities per minute could be registered before the auditory feedback became operative. That number of activities would be set to coincide with the reward criterion established for that child and would change with the criterion. This would enable each child to know the exact moment at which his activity had exceeded

its desirable level, or inversely, the lack of the feedback would indicate to him that his activity level was within an acceptable range. While this added design feature was not within the range of the resources available for this study, since this study was completed, other experimenters have designed just such a monitor.

Schulman, Stevens, and Kupst (1977) designed their "biometer" to both objectively measure activity level and provide feedback for excessive levels of activity. Their biometer was designed to function much like the activity monitor for this present study with two significant differences; one relating to its feedback function and one relating to its measurement function.

The biometer has a major advantage over the activity monitor designed for the present study. It contains a panel of switches which allow the experimenter to select an acceptable activity level criterion and only activity registered beyond this criterion would trigger the auditory feedback signal. These experimenters (Schulman, Stevens, Suran, Kupst, & Naughton, 1978) have found the biometer a useful tool, used in conjunction with an operant conditioning programme, to both increase the activity level of a hypoactive boy in a play situation and to decrease the activity level of a highly active boy in a classroom setting. No attempt was made, however, to test whether or not the feedback element in Schulman et al.'s

(1978) experiment actually faciliated the conditioning programme.

Activity Monitor as a Measurement Device

The biometer's use of a unitary activity level measured at the subject's waist contrasts with the activity monitor's use of three target positions at which activity level is measured and raises the question of the relative validity and utility of these two approaches.

The biometer's mercury switches placed only at the subject's waist could only measure gross motor activity. One may ask whether or not fine motor activity is a significant independent component of the activity level of overactive children. Pre-experimental observations of the children chosen for this study suggested that movement of the limbs frequently occurred independently of one another as well as independently of torso movement. Furthermore, data from this experiment demonstrates that movement of one body part does not always coincide with movement of another, and that for any one subject the three activity rates were rarely at the same level. One subject could therefore demonstrate that his fine motor activity level (measured at either arm) was more problematic than his gross motor activity level (measured at his torso) while another subject could demonstrate the contrary. It is this experimenter's opinion that this would be relevant information to have and could lead to treatment directed more specifically at the problematic component of the

subject's activity level. One might point out that since treatment of activity level of two body parts (in this case the non-dominant arm and torso), generalized to another target body part, more specifically directed treatment is unnecessary. However, it is possible that this generalization occurred to some extent because of a relationship between the activity levels of the two arms or even because of a relationahip between the torso and the dominant arm. It should not be assumed without experimental verification that treatment of activity level at any one body position will necessarily generalize to all body positions. In fact, this was not even always the case in this study.

Suggestions for Further Use of the Activity Monitor

While the activity monitor's flexibility of placement of the mercury switches might be advantageous in terms of enabling the experimenter to adjust the switches in order to measure and modify the type of activity that is most problematic for the target subject, there is no doubt that a valid, reliable, standardized instrument for measuring activity level is in great need. As has been previously discussed, a major problem facing those studying hyperactivity or high activity levels, is the lack of an operational definition of those terms. One does not know whether or not what one experimenter is calling a hyperactive or overactive child coincides with

another experimenter's definition of these terms. A standardized instrument for measuring activity level would enable researchers to take the first necessary and long overdue step of defining what is a normal activity level and then deciding whether or not a particular child differs significantly from this. MacKeith (1974) suggests that only those children with an activity level two standard deviations above a normal activity level should be labelled hyperactive. The establishing of normative data could also provide the foundation for answering such questions as whether it is activity level per se or the nature of the activity that is the relevant feature of the distinction between what teachers, parents, and the medical profession label hyperactive or overactive and normal children. Furthermore, a better idea of what the activity level norm is would help researchers and clinicians set reasonable goals in their attempts to modify activity levels in those children who have been found to be overactive.

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APPENDIX I

ACTIVITY MONITOR

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ACTIVITY MONITOR

This device is capable of monitoring activity (movements) from five different locations and will record the tallies in four different accumulators (two inputs are stored in the same accumulator, i.e., they are summed). Each accumulator can store up to 4,095 "activities" and upon request from the operator, its contents can be displayed on a LED (Light Emitting Diode) array. The device also has an audio output (ear phone) which can be used for immediate information feedback. This audio output generates a one-second, one thousand Hertz tone burst whenever there is "activity" at any one of three specified inputs. The operator can select various functions from an eight pole rocker switch mounted on the device. The entire electronic package is assembled in a 10 x 15 cm printed circuit board and has a width of approximately 1.5 cm. The battery (a standard 9-volt transistor radio battery) is separate from the electronics and is connected via a clip-on type connector. Including the battery, the whole package weights approximately 110 grams.

Activity (movement) is detected with mercury switches (Honeywell type AS408D). The switches are placed in such an attitude that any movement causing the mercury switch to tilt more than 12^0 will cause the mercury to move, in turn causing the two contacts in the switch to be open or closed (see Figure 12).

Any activity or movement which causes the mercury switch to close, triggers a one-second, one-shot circuit (see Figure 12) at the input to each of the four accumulators. This one-shot circuit can be triggered only once every second, thus defining an "activity" as lasting at least one second. That is: there will be a maximum of one count per second recorded for any series of movements. This circuit also eliminates any contact bounce which might occur when the switch is moved.

The output of each one-shot is counted in four twelve-bit accumulators (MC14040's). The twelve outputs of each accumulator can be tri-stated (connected or not connected) through two six-bit drivers (MM80C79's) to the LED's. The contents of the desired accumulator can be selected by depressing the appropriate rocker switch which in turn generates an enable signal to the corresponding tri-state drivers.

The accumulator enable outputs of the eight pole rocker switch are fed through a BCD coder (MM74C42) to insure that only one accumulator is selected at any one time. The contents of the selected accumulator are determined by summing the numbers beside the "on" LED's.

The outputs of two of the one-shot circuits are also used to gate the 1000 Hertz oscillator used for feedback. The output of this oscillator is fed to a crystal earphone through a resistor divider circuit (8.2K ohms and 1.5K ohms).

In addition to selecting the desired accumulator outputs for the readout, the rocker switch is used to turn the power on and off and to clear the accumulators before a set of readings is taken.

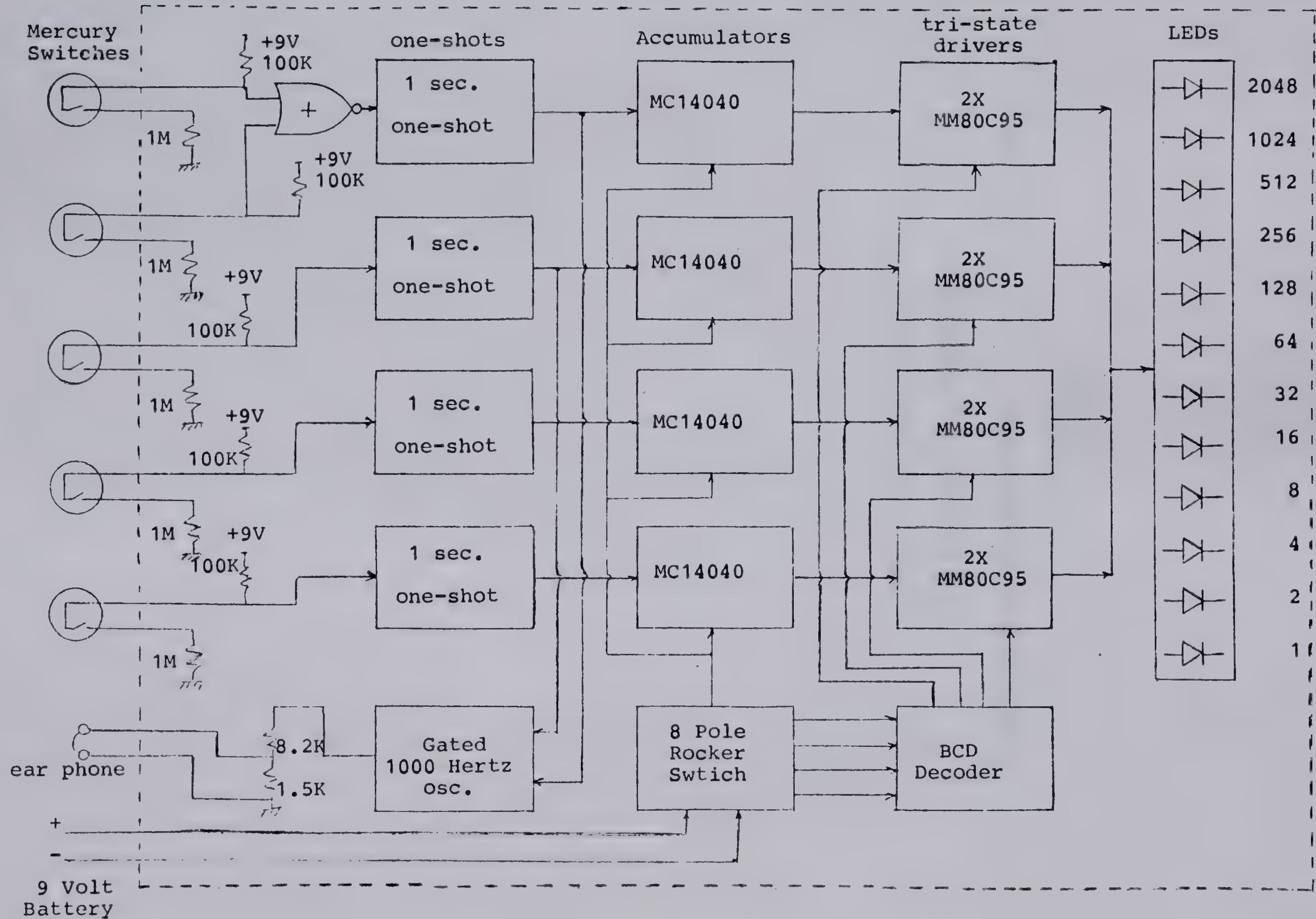

Figure 12. Activity Monitor

APPENDIX II

INSTRUCTIONS FOR TEACHERS FOR OPERATING AND RECORDING OUTPUT FROM ACTIVITY MONITOR

Instructions for Teachers for Operating and

Recording Output from Activity Monitor

Baseline Sessions

Sessions Number: ______ Date: ________________

<u>BEFORE SESSION</u>

1. Push 2 and 3 down, rest up.
2. Push 4 down, then up again. Record time: __________

<u>AFTER SESSION</u>

1. Record time: ______________
2. With 2 and 3 down, rest up, push 5 down, record: _______
3. Push 5 up, 6 down, record: __________
4. Push 6 up, 7 down, record: __________
5. Push 7 up, 8 down, record: __________

<u>ALL UP</u>

Instructions for Teachers for Operating and

Recording Output from Activity Monitor

Treatment Sessions

Session Number: _________ Date _____________________

<u>BEFORE SESSION</u>

1. Push 1, 2, and 3 down, rest up.
2. Push 4 down, then up again. Record time: ___________

<u>AFTER SESSION</u>

1. Record time: _______________
2. With 1, 2, and 3 down, rest up, push 5 down, record: _____
3. Push 5 up, 6 down, record: _________
4. Push 6 up, 7 down, record: _________
5. Push 7 up, 8 down, record: _________

<u>ALL UP</u>

APPENDIX III

PARENTAL AUTHORIZATION AND CONSENT FORM

AUTHORIZATION AND CONSENT
FOR INVESTIGATIVE, RESEARCH PROCEDURE

The objective of this research is to test a device that will measure the activity level of children in the classroom and to try to help children, whose activity levels seem to interfere with their school performance, to reduce their own activity levels. The actual device is a small activity sensor which is contained in a pouch which is sewn into a light weight shirt and provides a record of the number of movements that the child makes over a period of time. The shirt will be worn during 3 class periods a day for approximately 5 or 6 weeks. The first two weeks will only involve keeping a record of his movements. The next three or four weeks will involve the treatment phase of the programme. During this phase the child will earn points by lowering his activity level. He can then use these points to obtain rewards. He will also have a small earphone in one ear through which he will hear a short beep whenever he moves inappropriately. This should act as a reminder to him that he should be moving less.

Before the actual research begins the child will be requested to wear the jacket for about an hour in a laboratory setting to establish whether or not the device will accurately measure his activity level.

____
Patient

1. I hereby authorize S. Litman and/or such assistants as may be required to perform the following procedure:

   Research into Activity Level as described above.

2. This procedure has been explained to me and I understand the purpose and nature of the procedure.

   Patient's Signature ______________________________

   ______________________________ (Parent/Guardian) ______________________ (Relationship)

   ______________________________ (Witness) ______________________ (Date)

   Authorization must be signed by Parent/Guardian if patient is a minor or is unable to sign.